Chapter 8
DEVELOPMENT OF SURFACES

8.1 INTRODUCTION

We brush our teeth daily but have you ever noticed the shape of packing box of tooth paste. Is it similar to a square prism? Let us open the box from its joints and lay down it on a plane surface. What do you observe? It is a piece of hard paper, having a rectangular shape with crease/folds on all bends. This shape is known as TRUE SHAPE of object/box and the process of unfolding of surfaces of a solid is called **Development of Surfaces.**

Can we take more examples? Yes, every packing box, birthday cap etc. can be opened up in the same way. Steel almirahs, buckets, storage vessels etc are bulky and complicated but these are also made up of sheet metal or plates from the **TRUE SHAPE** of objects.

In this chapter, we are going to study about the development of surfaces to find out the true shape of objects required to produce the three dimensional object. The knowledge of development of surfaces not only gives us the model of the object but also helps in the estimation of costing and process of manufacturing i.e. blanking, stamping, pressing, welding, riveting etc.

8.2 DEVELOPMENT OF SURFACES

If the surface of a solid is opened out and laid on a plane surface. The true shape of the surface area of the solid is obtained. It is known as the development of that solid.

The technique used in making a development from the orthographic views of a given object, is to find out the true shape of the surfaces and correct placement of one surface with respect to another adjacent element. "A development is a plane surface, which represents the unfolded surface of the object" Figure 8.1 explains the unfolding process of a cube to get its development.

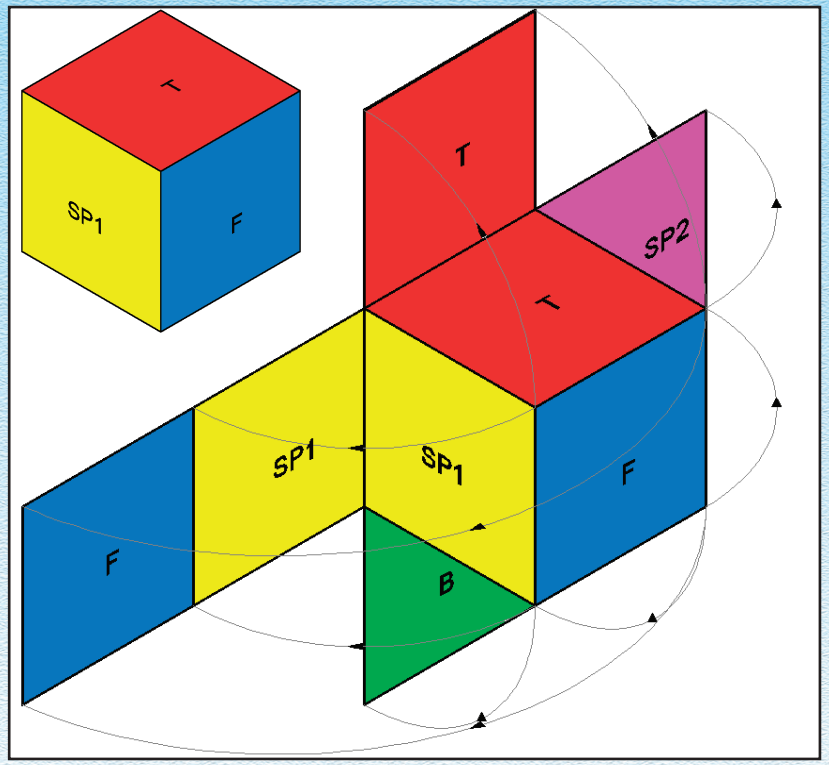

Fig. 8.1

8.3 METHODS TO DRAW DEVELOPMENT OF SURFACES

The group of developments, classified according to the type of surface involved to construct the development are as follows :-

1. Parallel line developments
2. Radial line developments

8.3.1 PARALLEL LINE (RECTANGULAR) METHOD

In this method development of surfaces of prisms and cylinders is drawn with the help of parallel lines. In this method the lateral surfaces of a solid are divided into a number of convenient rectangles. The true length of each of the side of the rectangles is found out from the orthographic views of the solid. Using these true lengths the rectangles are drawn, sequentially, one besides the other. Usually, as the height of the Front View and development is the same, the development is drawn in horizontal alignment with the Front View. The addition of two end surfaces to the lateral surface gives the complete development of the solid.

Development of the cylinder is obtained by dividing the cylindrical surface into "equal" parts with the help of generators.

8.3.1.1 CUBE

The development of the surface of a cube consists of six equal squares of side equal to the edge of the cube.

Example 8.1 : Draw the development of surface of a cube of side 40 mm.

Solution : Refer to fig. 8.2

Steps :

1. Draw the Front View and Top View of the cube.
2. Draw the base line in horizontal alignment to the Front View and on it draw four faces (i.e. squares) of the cube.
3. Draw two faces (squares) of the cube on the first and last face.

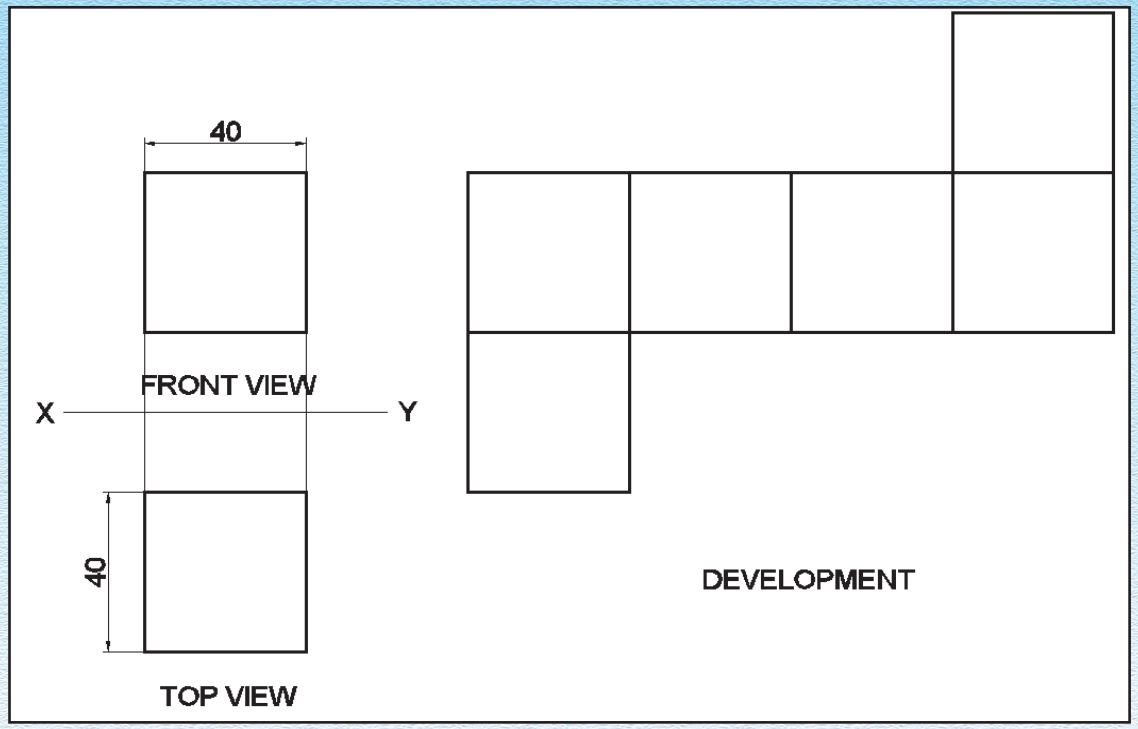

Fig. 8.2

8.3.1.2 CUBOID

The development of cuboid consists of six rectangles. Two rectangles have height (length) and width (breadth) as sides, while two rectangles have height (length) and thickness as sides. Two rectangles are drawn above and below on the first and third rectangle having width and thickness as sides. So there are three sets of two rectangles each.

Example 8.2 : Draw the complete development of a cuboid of sides 70 mm, 40 mm and 30 mm (l × b × t)

Solution : Refer to fig. 8.3

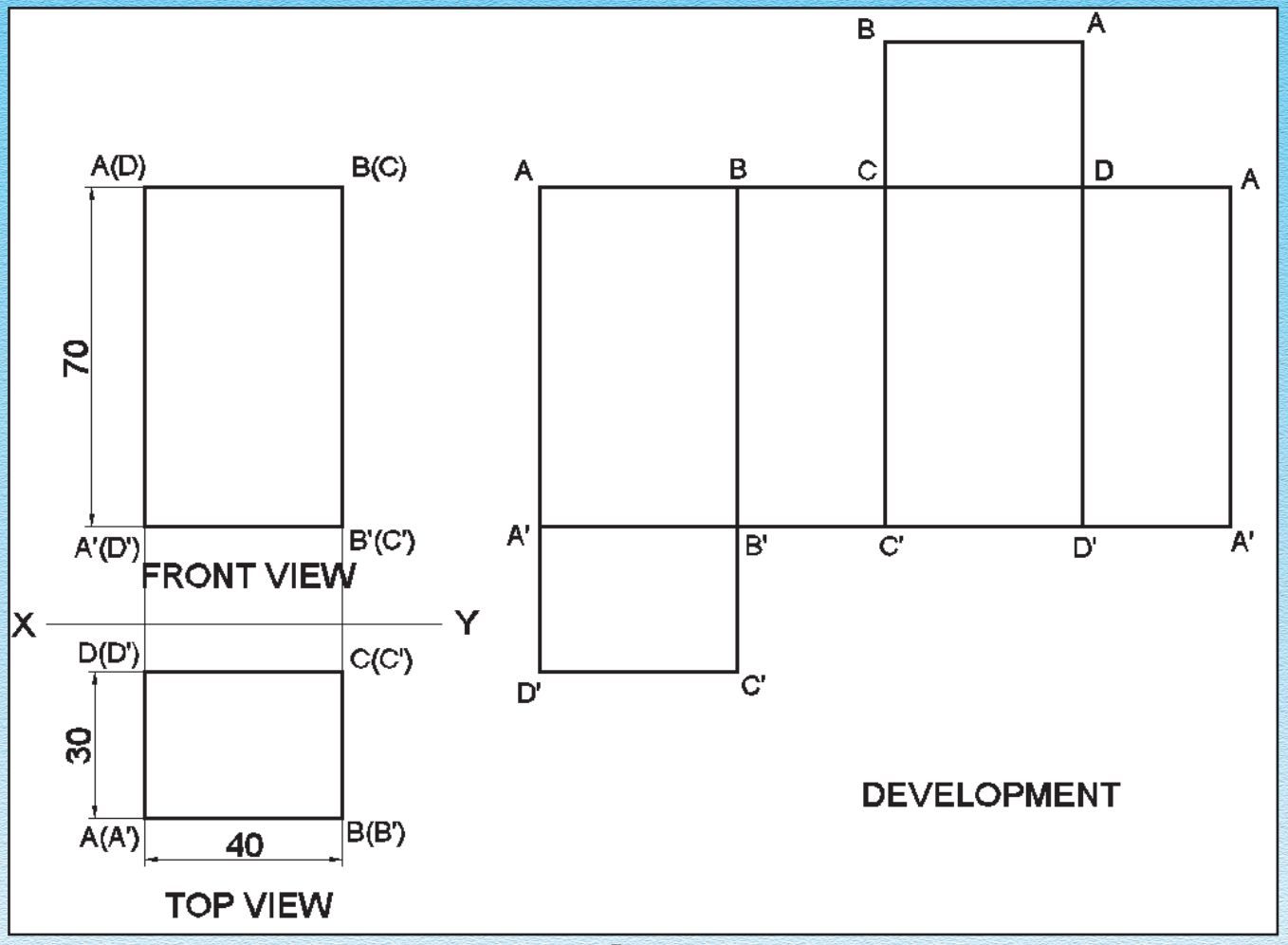

Fig. 8.3

Steps :

1. Draw the Front View and Top View of the cuboid.
2. Draw a base line in horizontal alignment to the Front View and mark line segments equal to A'B', B'C', C'D' and D'A' on it.
3. Draw the vertical line on point A equal to the length AA' (70 mm) in Front View now draw parallel lines from B', C', D' A' and complete the rectangle AA'A'A (140 × 70).
4. Complete the bases of the cuboid around two of its breadths.

8.3.1.3 PRISMS

Development of the prism consists of the same number of rectangles (faces) in sequence the number of the sides of the base of the prism. One side of the rectangle is equal to the length of the axis and another side equal to the base side. Two bases are added above and below the rectangle, on any base side. Let us draw some examples.

Example 8.3 : Draw the complete development of a triangular prism of 40 mm base edge and 60 mm long height.

Solution : Refer to fig. 8.4

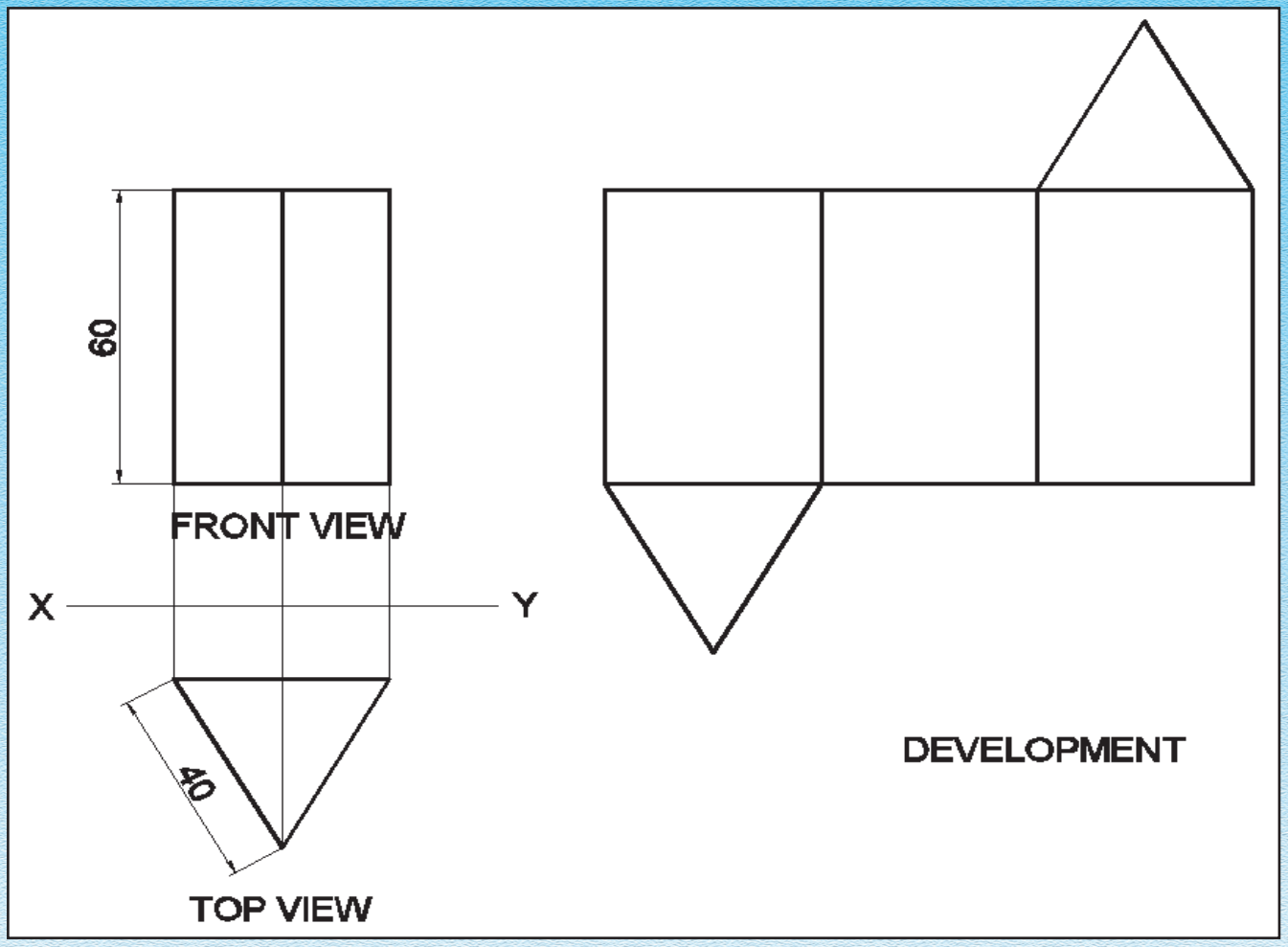

Fig. 8.4

Steps :

1. Draw the Front View and Top View.
2. Draw a base line parallel to XY and mark three line segments each equal to 40 mm.
3. Draw the projections from the Front View. Now draw the parallel lines and complete three rectangles of 60 × 40.
4. Complete the bases of the triangular prism on the first and last rectangles already drawn.

Example 8.4 : Draw the complete development of a square prism of base side 35 mm and height of 60 mm.

Solution : Refer to fig. 8.5

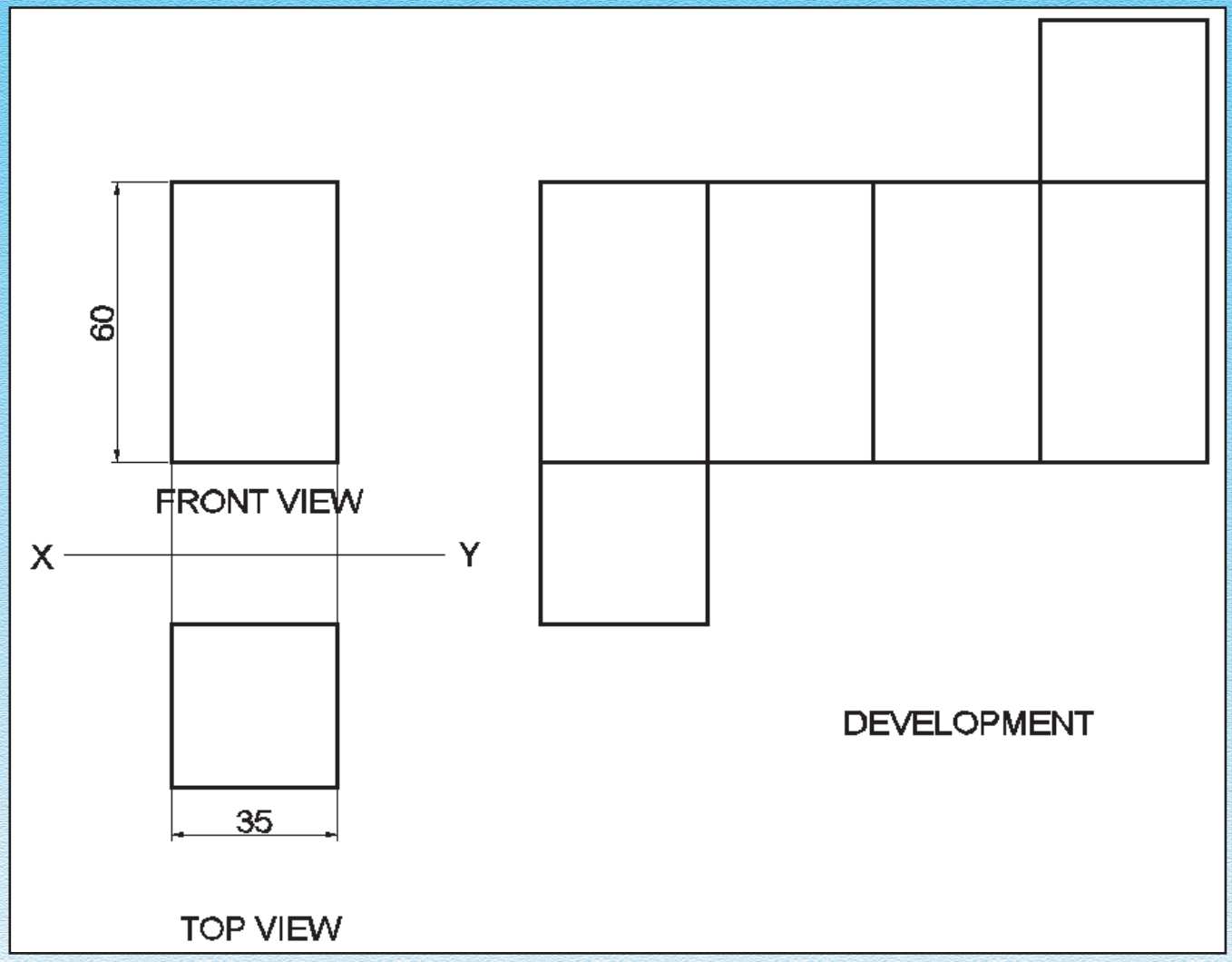

Fig. 8.5

Steps :

1. Draw the Front View and Top View of the square prism as shown in Fig. 8.5 (a)
2. Draw a base line parallel to XY and mark four line segments on it equal to the base side (35 mm).
3. Project the height from Front View of the prism, and complete the rectangle by drawing other parallel lines. (35×60 , 140×60)
4. Draw the bases of the prism i.e. squares on the first and last rectangles already drawn.

Example 8.5 : Draw the complete development of a pentagonal prism of 30 mm base edge and 50 mm long axis.

Solution : Refer to fig. 8.6

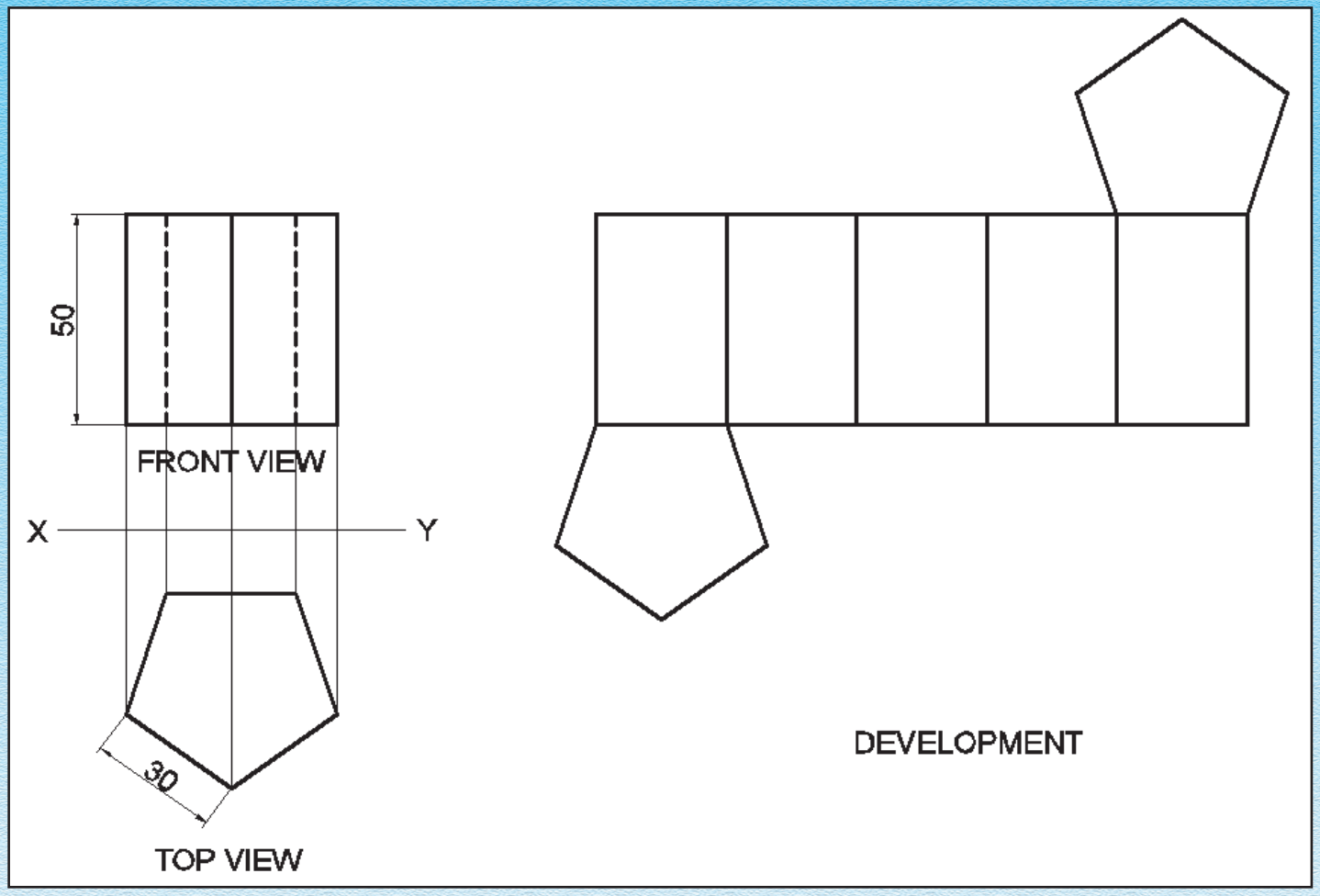

Fig. 8.6

Steps :

1. Draw the Front View and Top View of the prism.
2. Draw a base line in horizontal alignment to the Front View and mark five line segments equal to the base edge on it each = 30 mm.
3. Project the height from Front View equal to 50 mm and complete the rectangle. (150 × 50).
4. Draw the bases of the prism on the first and the last rectangles and complete the development.

Example 8.6 : Draw the development of a hexagonal prism of base edge 25 mm and axis 60 mm long.

Solution : Refer to fig. 8.7

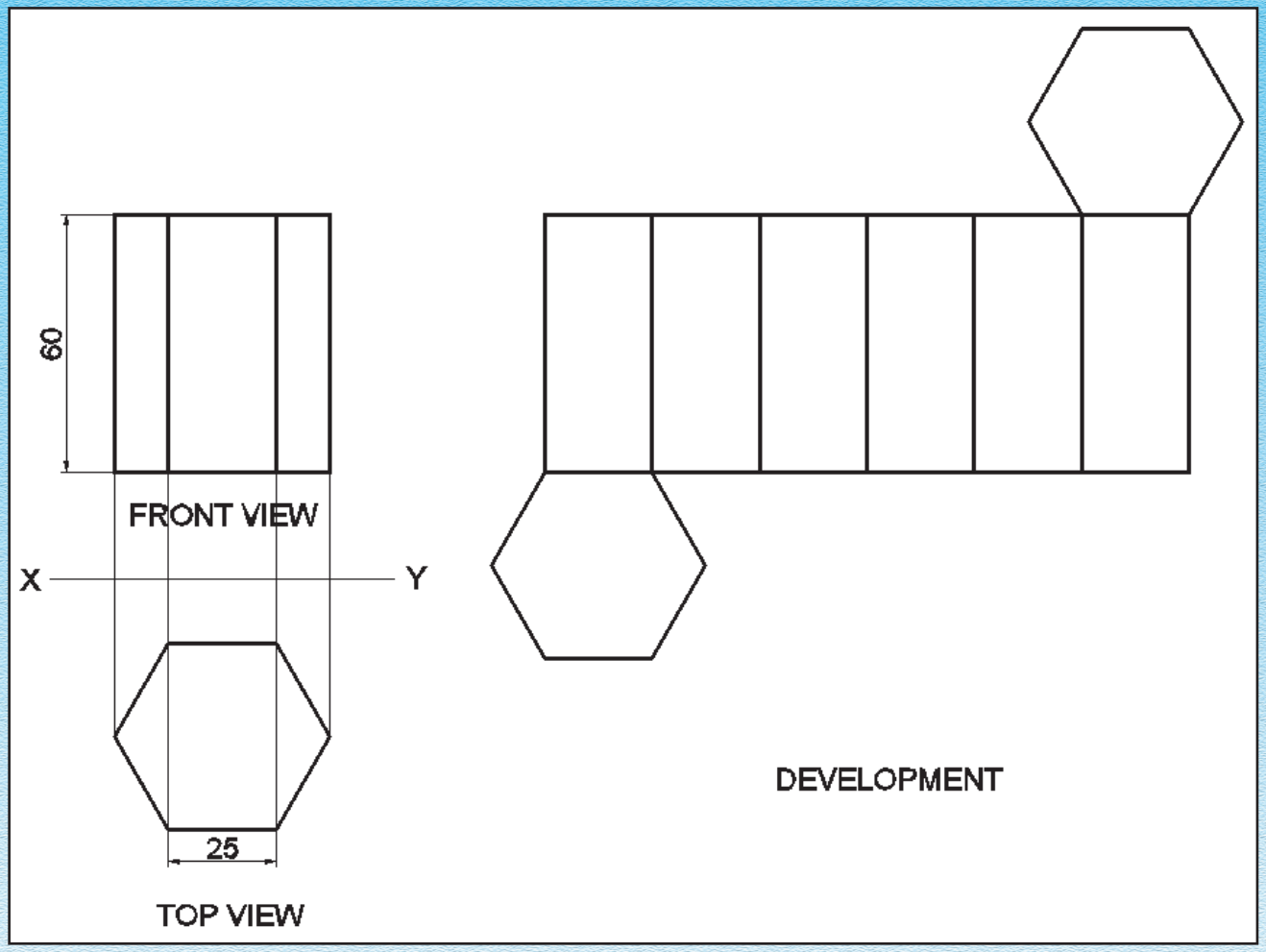

Fig. 8.7

Steps :

1. Draw the Front View and Top View.
2. Draw a base line in horizontal alignment to the Front View and mark six line segments equal to the base edge on it, each = 25 mm.
3. Project the height from Front View equal to 60 mm and complete the rectangle (150 × 60 mm)
4. Draw the bases on the first and the last rectangle and complete the development.

8.3.1.4 CYLINDER

Cylinder does not have any face edge so the development of cylinder is drawn by dividing the cylindrical (curved) surface into no. of equal rectangles (approximately) through generators. The most appropriate no. of equal rectangles are twelve.

Example 8.7 : Draw the development of a cylinder of 40 mm diameter and 60 mm high.

Solution : Refer to fig. 8.8

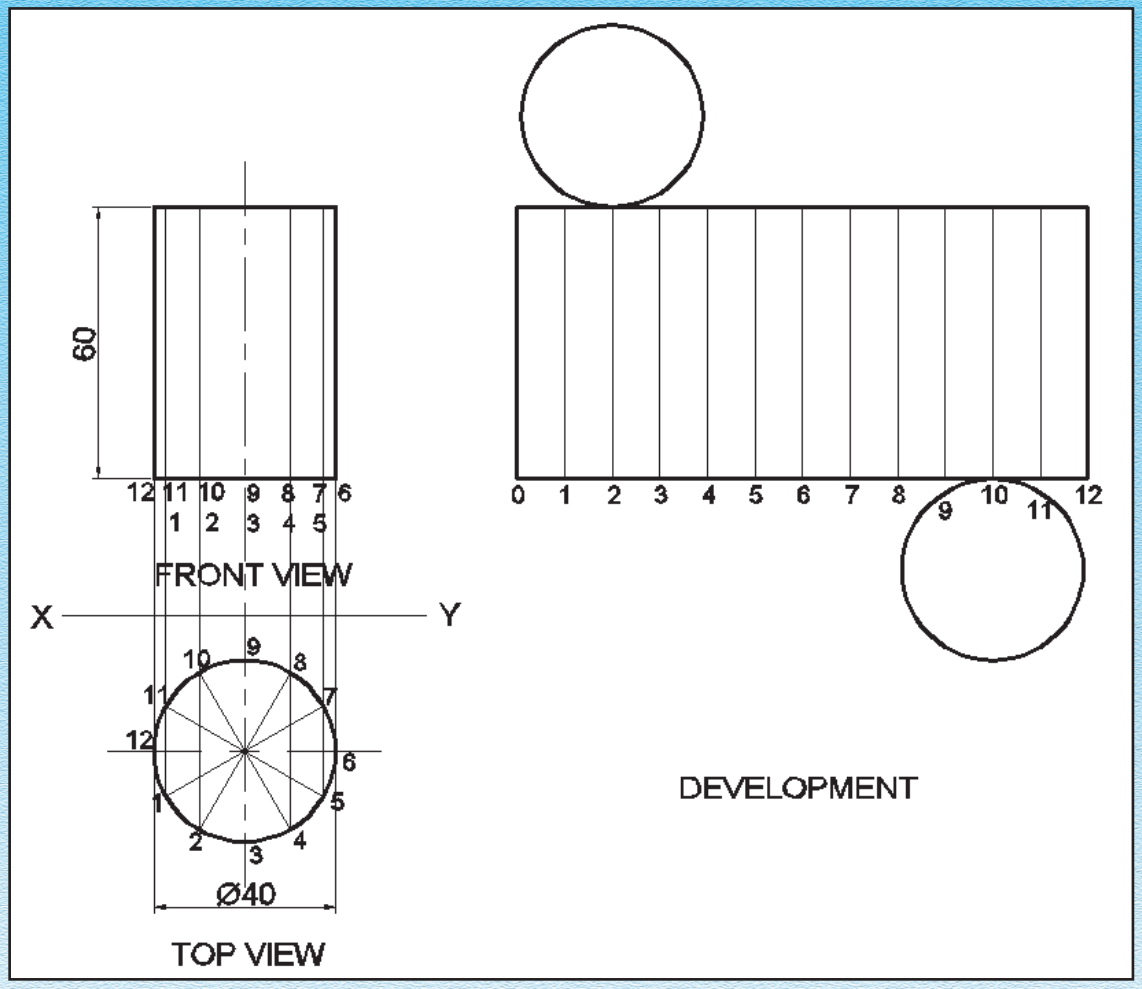

Fig. 8.8

Steps :

1. Draw the Front View and Top View of the cylinder.
2. Divide the circle in Top View into twelve equal parts at 30° and 60°. Project these points to the Front View to locate and draw the generators.
3. Draw the development in horizontal alignment of the Front View along with the generators. The distance between generators is taken equal to the chord length (1–2).
4. Draw two circles above and below on any two generators, Touching the rectangle as shown.

8.3.2 RADIAL LINE (TRIANGULATION) METHOD

Development of surfaces of pyramids is drawn by this method. According to this method, the surface is developed with the help of isosceles triangles, whose isosceles sides are equal to true length of slant edge and the third side is equal to base side. To draw the isosceles sides of all these triangles adacent to each other we take the arc of radius equal to the true length of slant edge. The centre of that arc becomes the vertex of triangle. The base edges are marked on the arc. The base of triangle is drawn on any one of the base edge. The true lengths of base edge and slant edge are taken from the Front View and Top View of that solid.

8.3.2.1 PYRAMIDS---SLANT (FACE) EDGE PARALLEL TO V.P.

When solid is kept in such a position that one of the slant edge is drawn parallel to the V.P. Then slant edge drawn in Front View will be its true length. Let us draw some examples.

Example 8.8 : Draw the development of a Triangular pyramid of base edge 35 mm and 65 mm high.

Solution : Refer to fig. 8.9

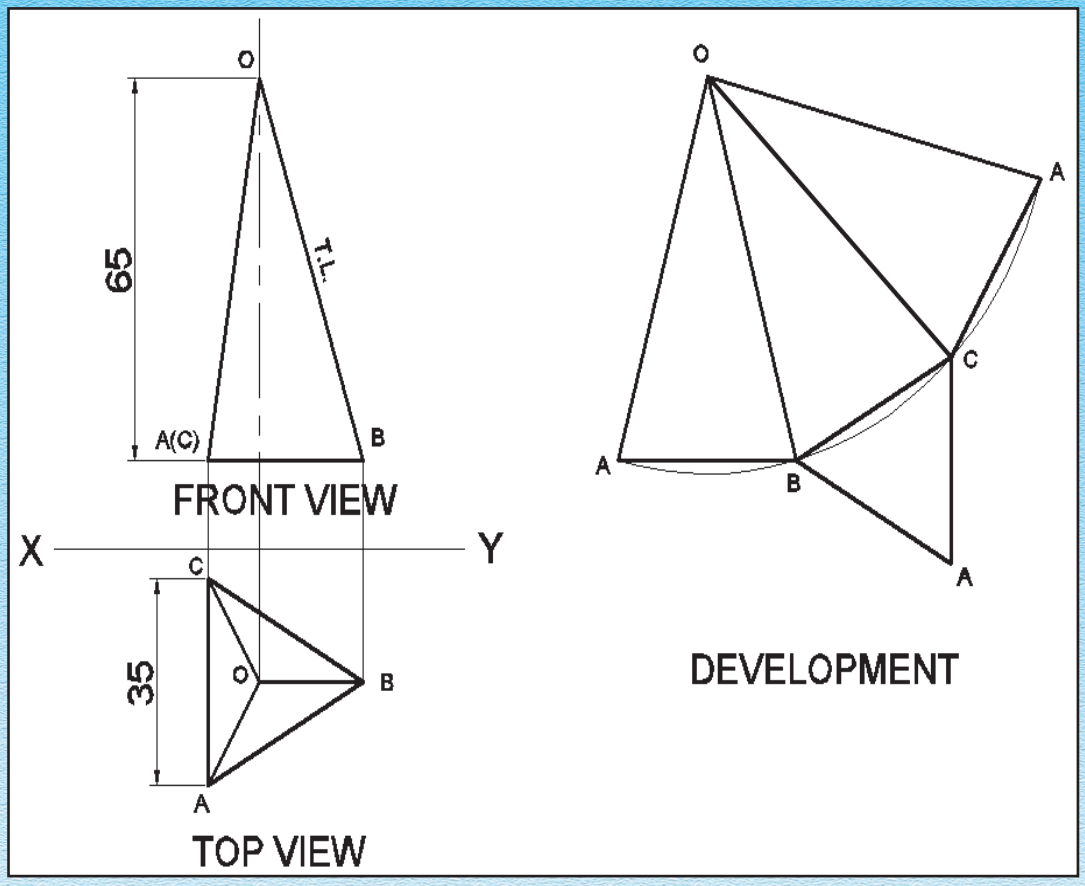

Fig. 8.9

Steps :

1. Draw the Front View and Top View of the given pyramid, keeping one of slant edge parallel to V.P. (O-B)
2. Take the length of the slant edge (O-B), from Front View, which is parallel to V.P. as radius and draw an arc.
3. Cut this arc at three points with a radius equal to base edge of the pyramid.
4. Join all these points with O as well as every point on arc with its adjacent point on arc.
5. Draw the equilateral triangle on any one of the base edge drawn on the arc adding the base.

Example 8.9 : Draw the development of a square pyramid of base side 30 mm and axes of 50 mm high.

Solution : Refer to fig. 8.10

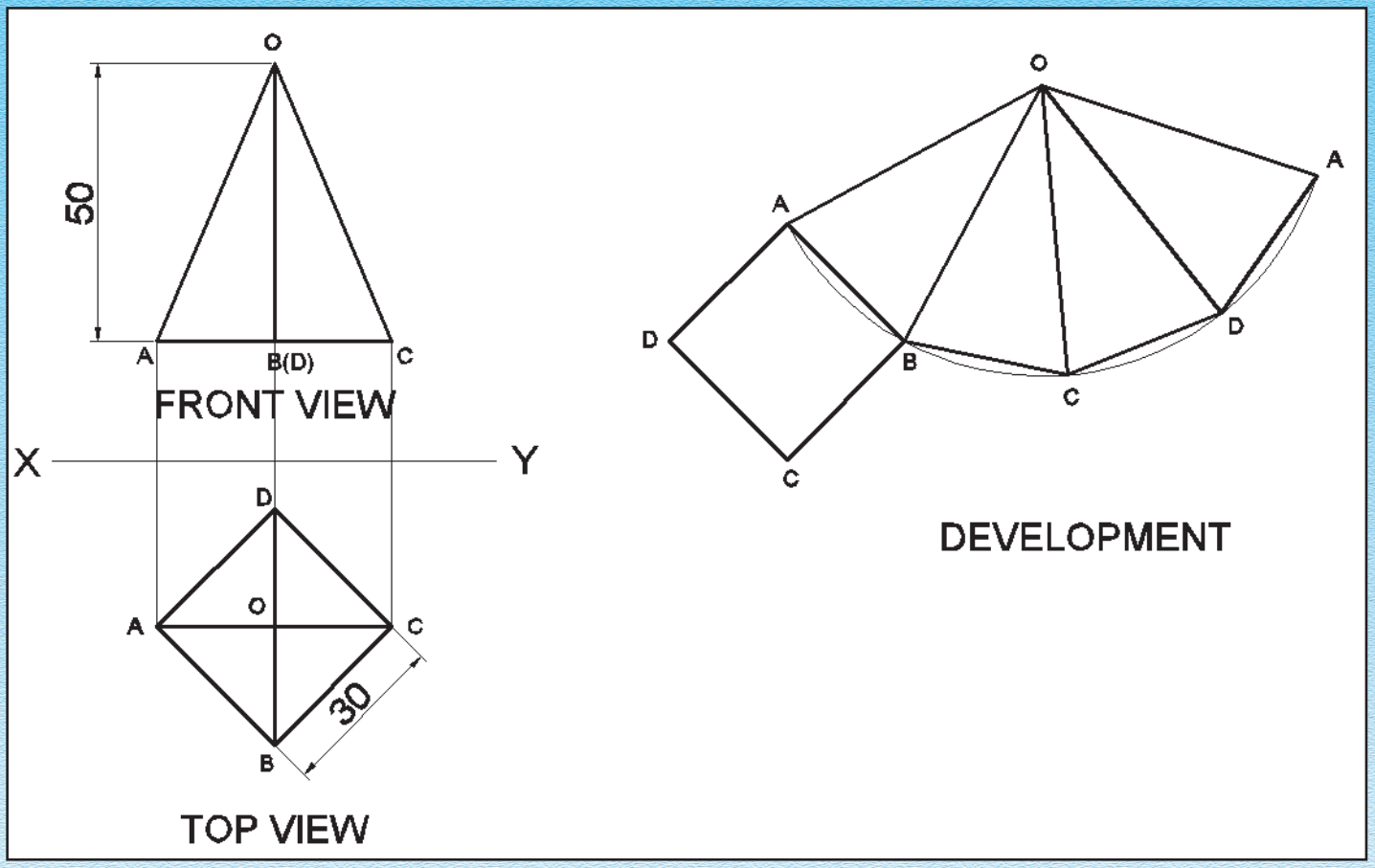

Fig. 8.10

Steps :

1. Draw the Front View and Top View of the given pyramid, keeping one slant edge parallel to V.P. (O-C)
2. Take the length of the slant edge (O-C), from the Front View, which is parallel to V.P. as radius and draw an arc.
3. Cut this arc at four points with a radius equal to base edge of the pyramid.
4. Join all these points with O and all the points on arc with its adjacent point on the arc.
5. Draw the square on any one of the base edge drawn on the arc adding the base.

Example 8.10 : Draw the development of a Pentagonal pyramid of base edge 25 mm and 75 mm high.

Solution : Refer to fig. 8.11

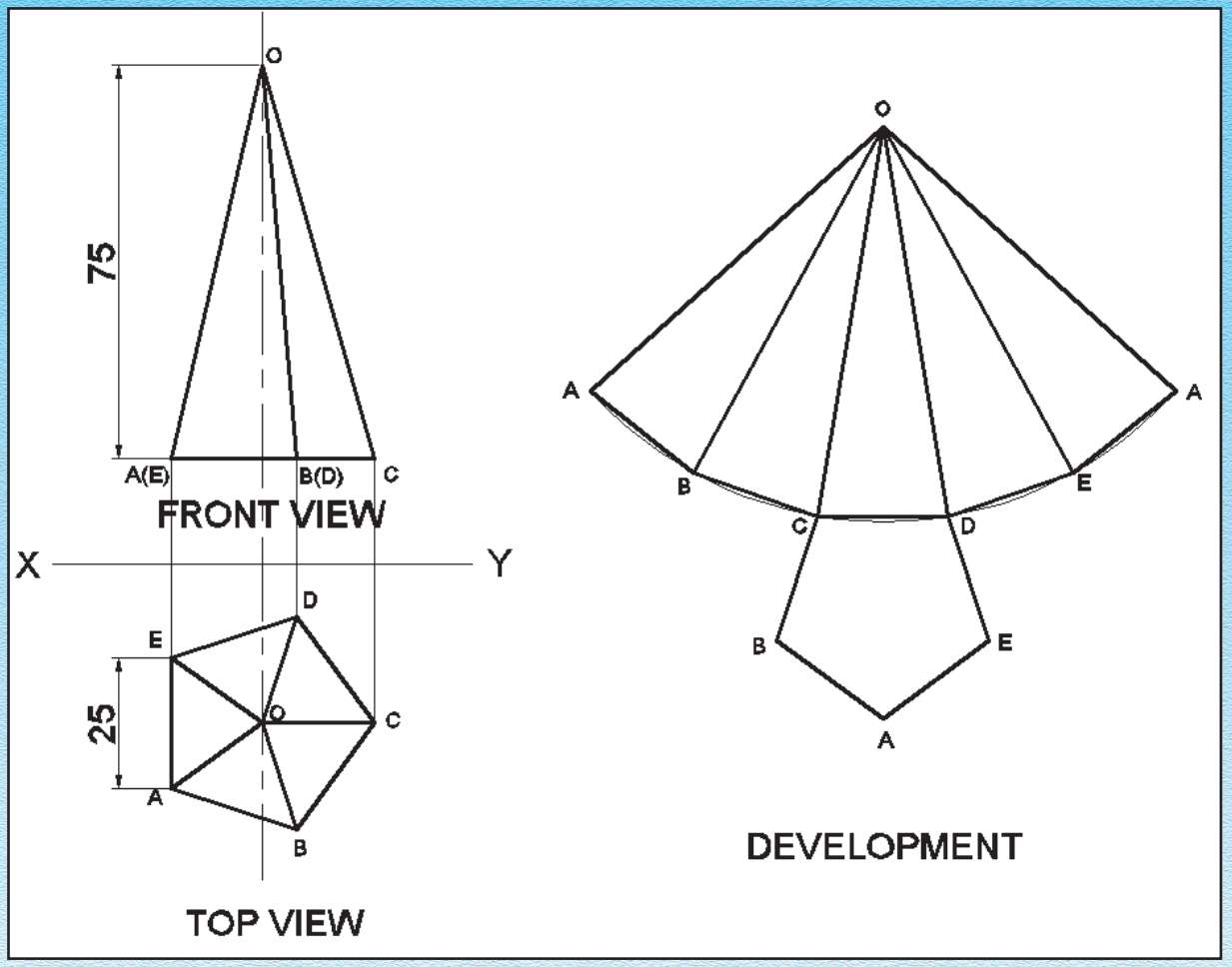

Fig. 8.11

Steps :

1. Draw the Front View and Top View of the given pyramid, keeping one of slant edge parallel to V.P. (O-C)
2. Take the length of the slant height (O-C), which is parallel to V.P. as radius and draw an arc.
3. Cut this arc at five points with a radius equal to the base edge of the pyramid.
4. Join all these points with O and each point on arc with its adjacent point on arc.
5. Draw a regular pentagon on any one of the base edge drawn on the arc, adding the base.

Example 8.11 : Draw the development of a hexagonal pyramid of base edge 25 mm and 50 mm long axes.

Solution : Refer to fig. 8.12

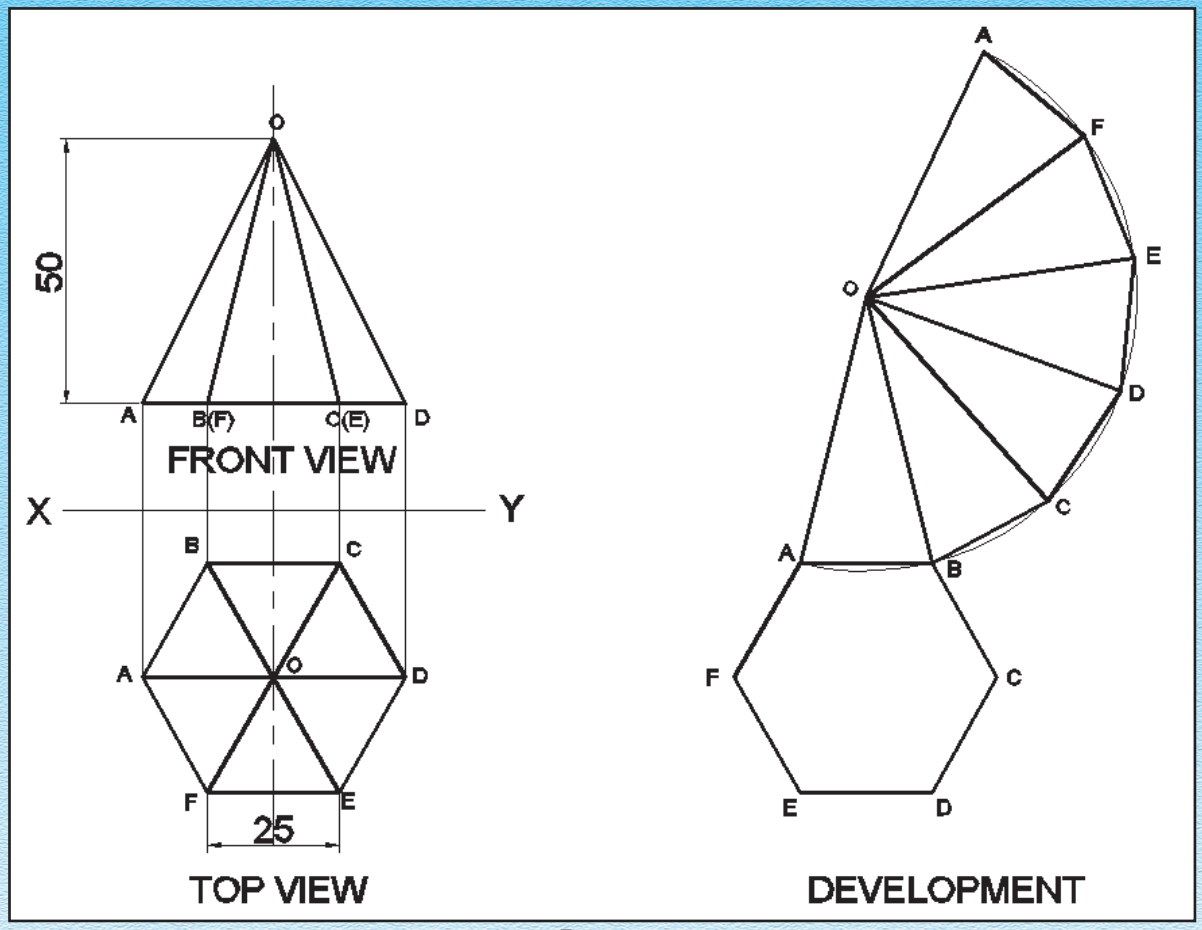

Fig. 8.12

Steps :

1. Draw the Front View and Top View of given pyramid, keeping one slant edge parallel to V.P. (O-D)
2. Take the length of the slant height (O-D), which is parallel to V.P. as radius and draw an arc.
3. Cut this arc at six points with a radius equal to the base edge of the pyramid.
4. Join all these points with O and each point on arc with its adjacent point on arc.
5. Draw a regular hexagon on any one of the base edge drawn on the arc, i.e. adding the base.

8.3.2.2 PYRAMIDS---SLANT (FACE) EDGE IS NOT PARALLEL TO V.P.

When solid is kept in a position that none of the slant edge is parallel to the V.P. Then true length of the slant edge is not shown in Front View. To find out its true length we turn the slant (face) edge in the Top View, parallel to the V.P. or XY and then project it in the Front View. Let us draw some examples :-

Example 8.12 : Draw the development of a triangular pyramid of base edge 30 mm and height of 60 mm.

Solution : Refer to fig. 8.13

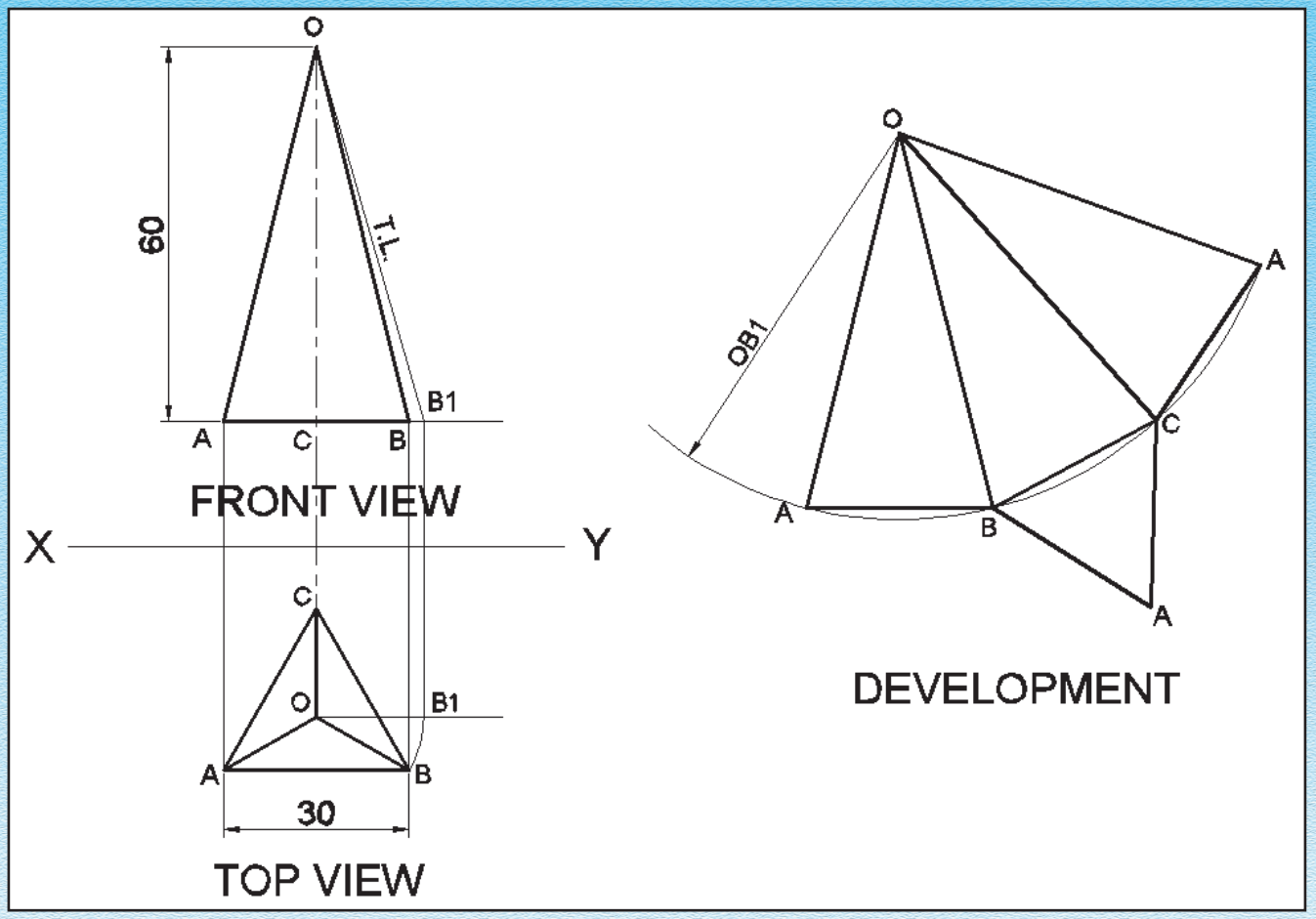

Fig. 8.13

Steps :

1. Draw the Front View and Top View of given pyramid.
2. Turn the slant (face) edge of Top View O-B parallel to the V.P. or XY, by taking radius equal to OB and O as center.
3. Project the point B_1 to the Front View and join OB_1, OB_1 is the true length of slant edge.
4. Take the length of the slant edge OB, from Front View as radius and draw an arc.
5. Cut this arc at three points with a distance equal to base edge of the pyramid.
6. Join all these points with O; and every point on arc with its adjacent point on arc.
7. Draw an equilateral triangle on any one of the base edge drawn on the arc, i.e. adding the base.

Example 8.13 : Draw the development of a square pyramid of base edge 40 mm and 65 mm height.

Solution : Refer to fig. 8.14

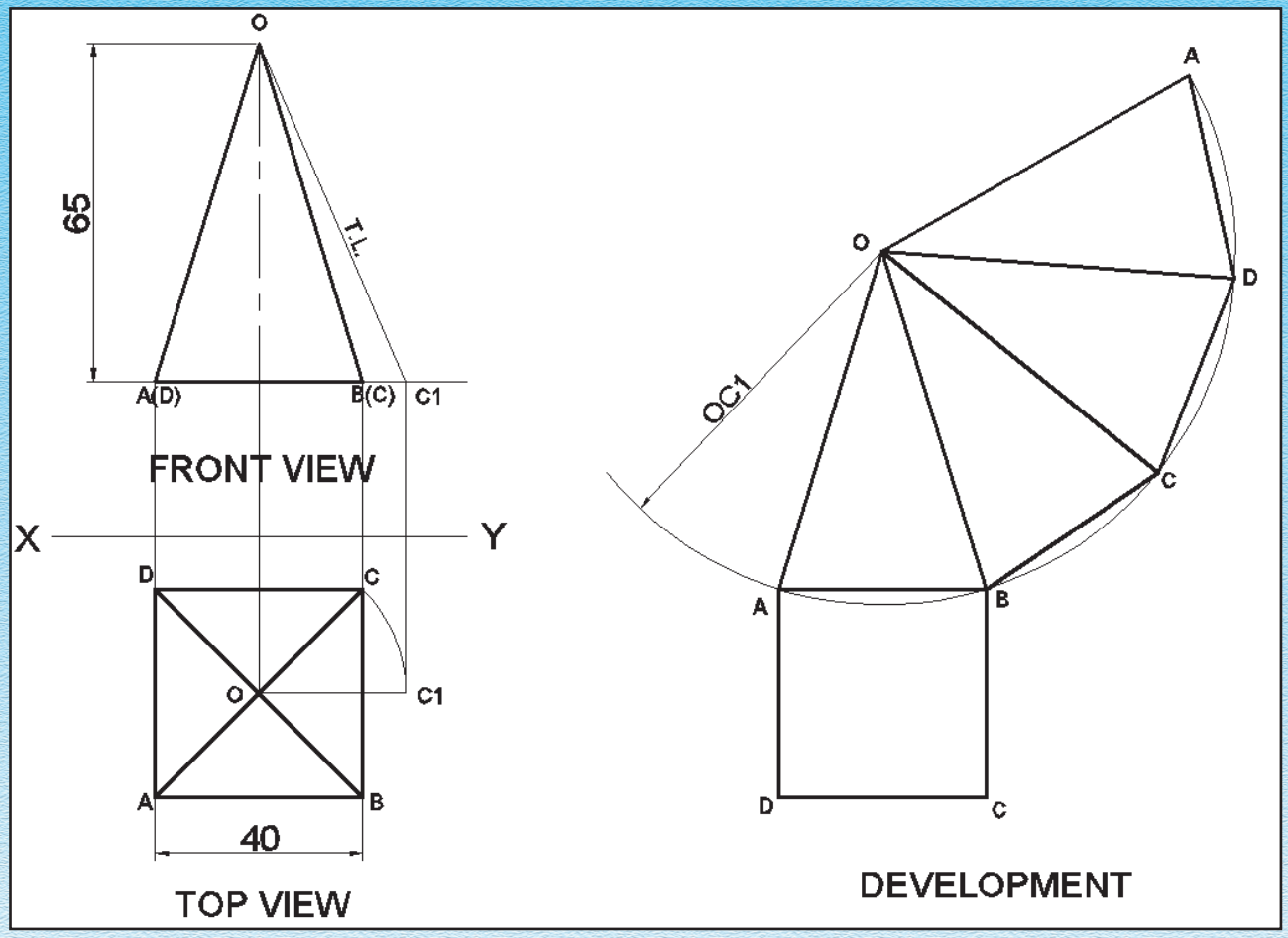

Fig. 8.14

Steps :

1. Draw the Front View and Top View of the given pyramid.
2. Transfer the corner of Top View C, parallel to the V.P. or XY, by taking radius equal to OC and O as center.
3. Project the point C_1 to the Front View and join OC_1, OC_1 is the true length of slant edge.
4. Take OC_1, as radius and draw an arc.
5. Cut this arc at four points with a distance equal to base edge of pyramid.
6. Join all these points with O; and every point on arc with its adjacent point on arc.
7. Draw the square on any one of the base edge drawn on the arc, i.e. adding the base to the development.

8.3.2.3 CONE

Cones are also having curved surface as in cylinders so the development of cone is also drawn by dividing the curved surface into no. of equal triangles (approximately) through generators. The most appropriate no. of equal triangles are twelve.

Example 8.14 : Draw the development of a cone of diameter 40 mm and height of the 60 mm.

Solution : Refer to fig. 8.15

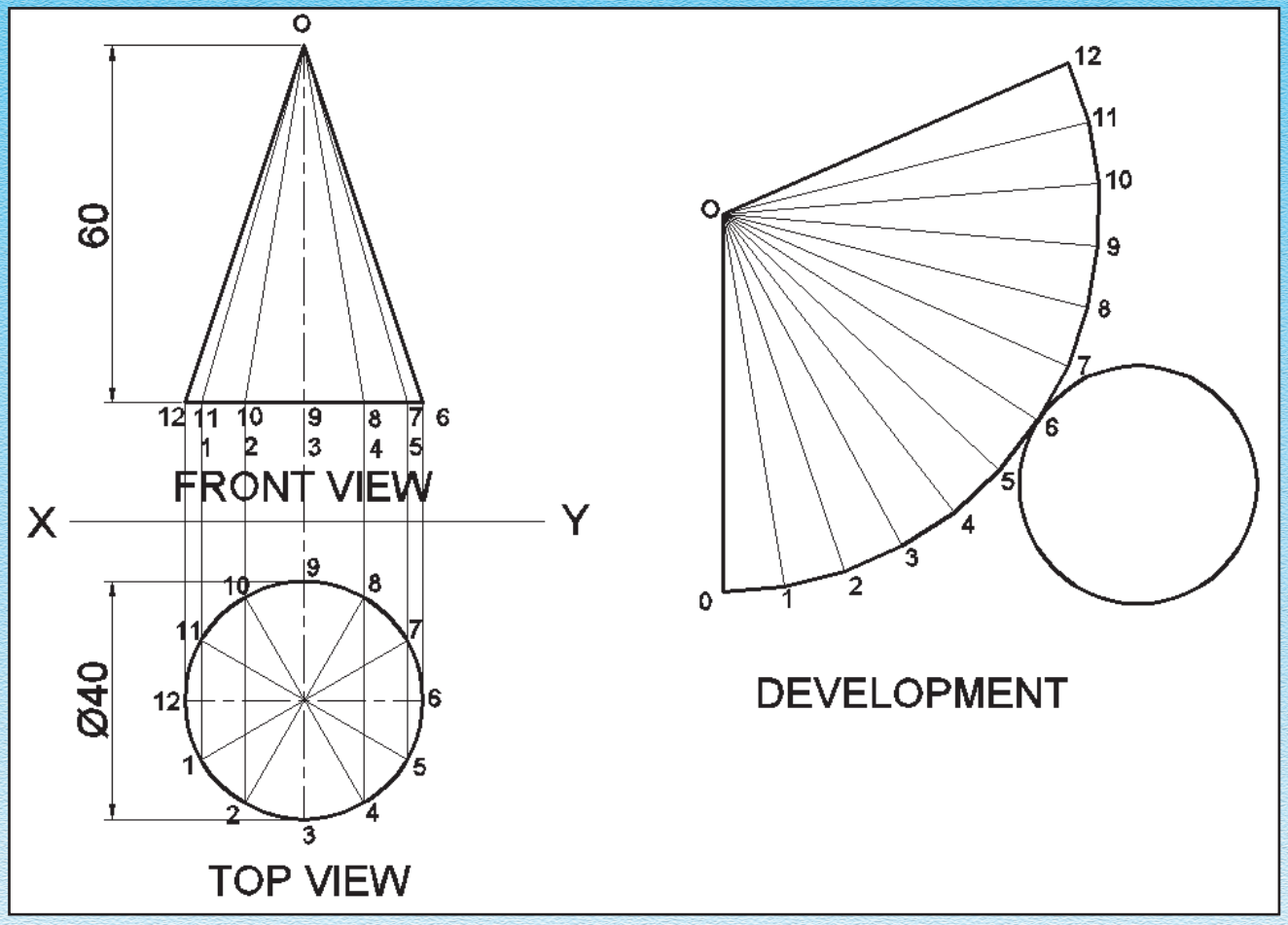

Fig. 8.15

Steps :

1. Draw the Front View and Top View of Cone.
2. Divide the circle in Top View into twelve equal parts at 30° and 60°. Project these points to the Front View to locate and draw the generators.
3. Take the slant height as radius and draw an arc.
4. Cut this arc in twelve points with the distance equal to the chord length 1-2 (from Top View).
5. Join the starting (O) and ending (12) point of the arc with O, and then draw the generators with thin lines.
6. Draw one circle on any one of the generator touching the arc. i.e. adding the base (dia = 40 mm).

WHAT WE HAVE LEARNT

We have learnt that every object is made up of surfaces and by the method of development of surfaces we can find out the true shape of the plane surface required to make, manufacture the object, which helps in to decide the steps involved, costing and estimation etc. of the object.

SHORT QUESTIONS

1. In drawing the development of objects, true lengths are used. (True/False)
2. True length of slant edge need not be known to draw a radial development. (True/False)
3. Every line on a development must be equal to the true length of that line on the actual surface (True/False)
4. Name the methods of development of right solids.
5. To develop the surfaces of pyramids, it is necessary to find _____ of the slant edges when they are not parallel to reference plane.

ASSIGNMENTS

1. Draw the development of a cube of side 50 mm.
2. Draw the development of a Triangular pyramid of base edge 30 mm and height of 60 mm.
3. Draw the development of a square prism of base side 35 mm and axes of 50 mm long.
4. A hexagonal prism of base side 30 mm and height of 60 mm is resting on its base with its axis perpendicular to the H.P. Develop its surface.
5. A cylinder having diameter of 40 mm and 65 mm high is kept on its base. Develop its surface.
6. Draw the development of a pentagonal prism of base side 30 mm and height of 55 mm.
7. Draw the development of a triangular pyramid of base side 35 mm and axis of 60 mm.
8. A pentagonal pyramid of base side 25 mm and height of 50 mm is kept on its base. Develop its surface.
9. Draw the development of a pentagonal pyramid of base edge 30 mm and 60 mm height.
10. Develop the surface of a cone of base diameter 50 mm and 60 mm axis.