

Chapter 5

SECTIONS OF SOLIDS

5.1 INTRODUCTION

We have studied about the orthographic projections in which a 3 dimensional object is detailed in 2-dimension. These objects are simple.

In engineering most of the machines are extremely complicated. They have various parts inside. And we have to show the details of inside, so the engineers adopt a technique called 'sectioning'. The objects/ machines are "imagined to be cut" in a particular manner and the interior becomes visible and is shown by a sectional view.

Let us take the machine block as shown in Fig. 5.1 Examine the orthographic views of this block. They have many hidden lines (showing invisible surfaces/edges) but don't give a clear idea about the inside details.

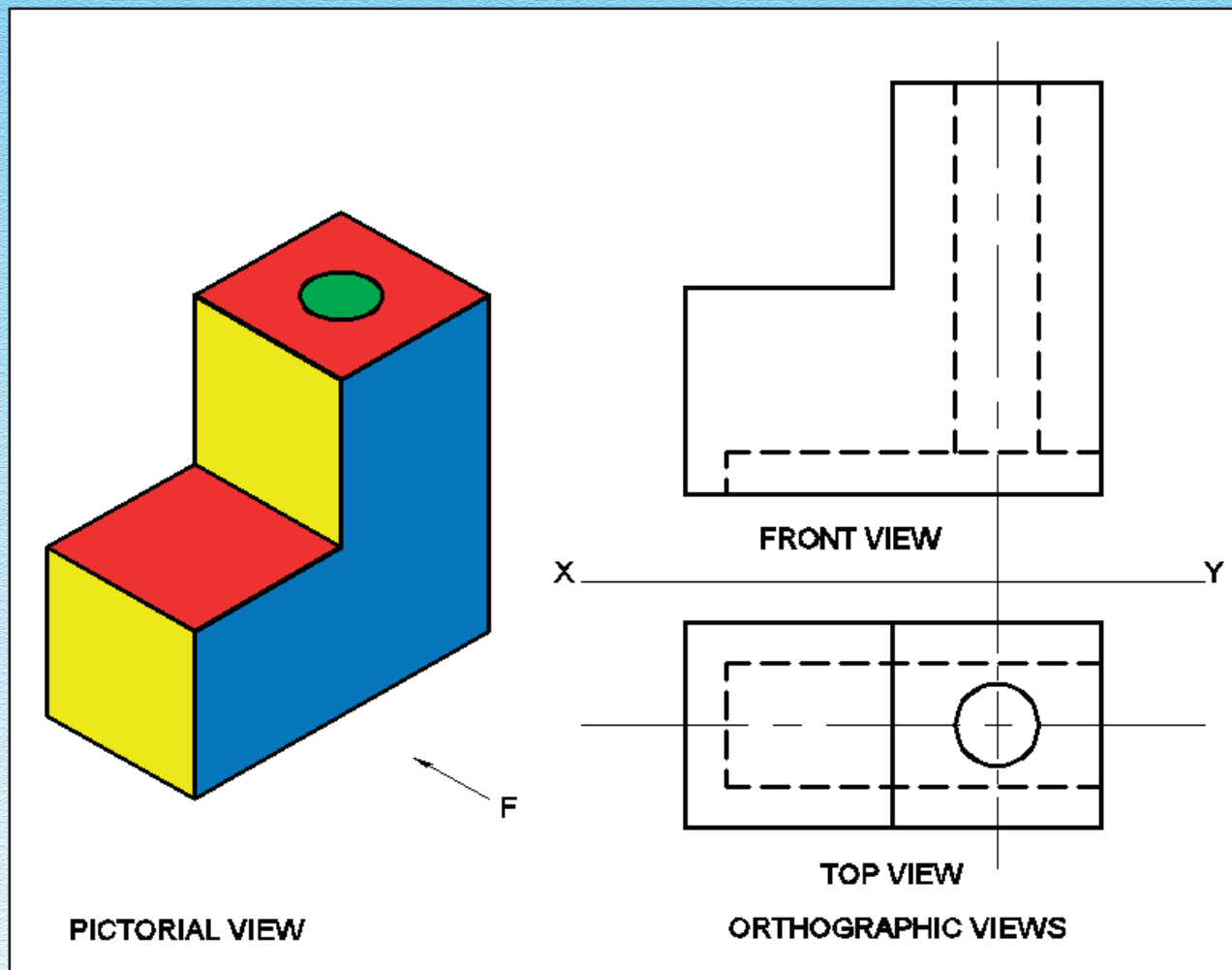


Fig. 5.1 Views of a Machine Block

So a portion/part of the object nearer to the observer is imagined to be cut and is removed away from the cutting plane, known as the 'section plane', to show the interior (inside) details more clearly. As can be seen in Fig. 5.2

The view (projection) of the remaining cut portion of the object is known as the **sectional view**. Refer to 5.2 (a) The cut/exposed surface, known as the **section** is represented by thin equidistant inclined lines (**section lines**) known as **hatching**. (Fig. 5.2 (a) & (b)).

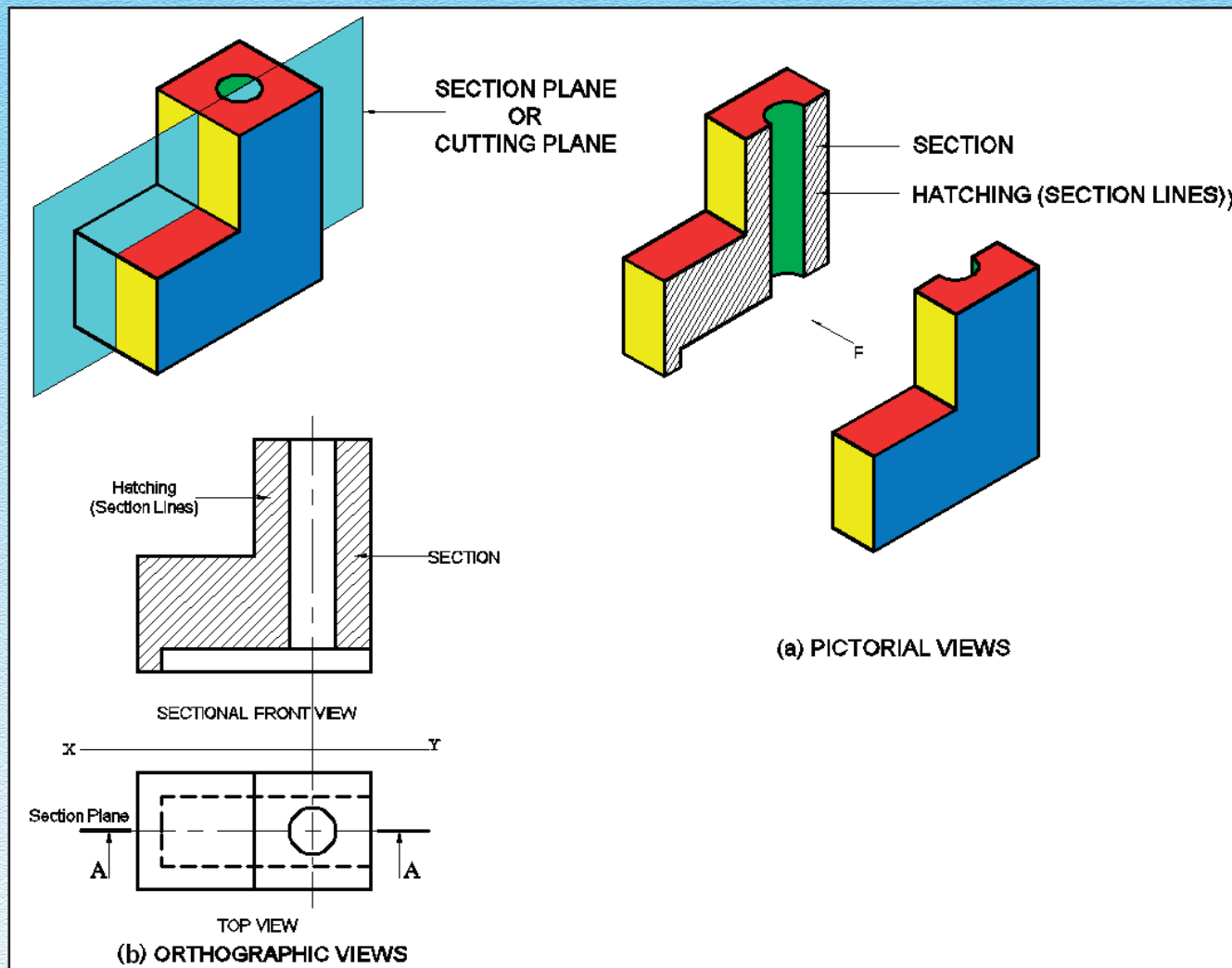


Fig. 5.2

5.1.1 Uses of Sections

We have come to know why sections are needed. Let us know some more details which are as follows :

- Sectioning helps the engineers/technicians considerably in clarifying the interior details (solid, hollow, etc.) These details are otherwise quite complicated to be shown & dimensioned by outside views & hidden lines.
- It may also be used to show a small cross section (perpendicular to axis) of a machine part as shown in Fig. 5.3

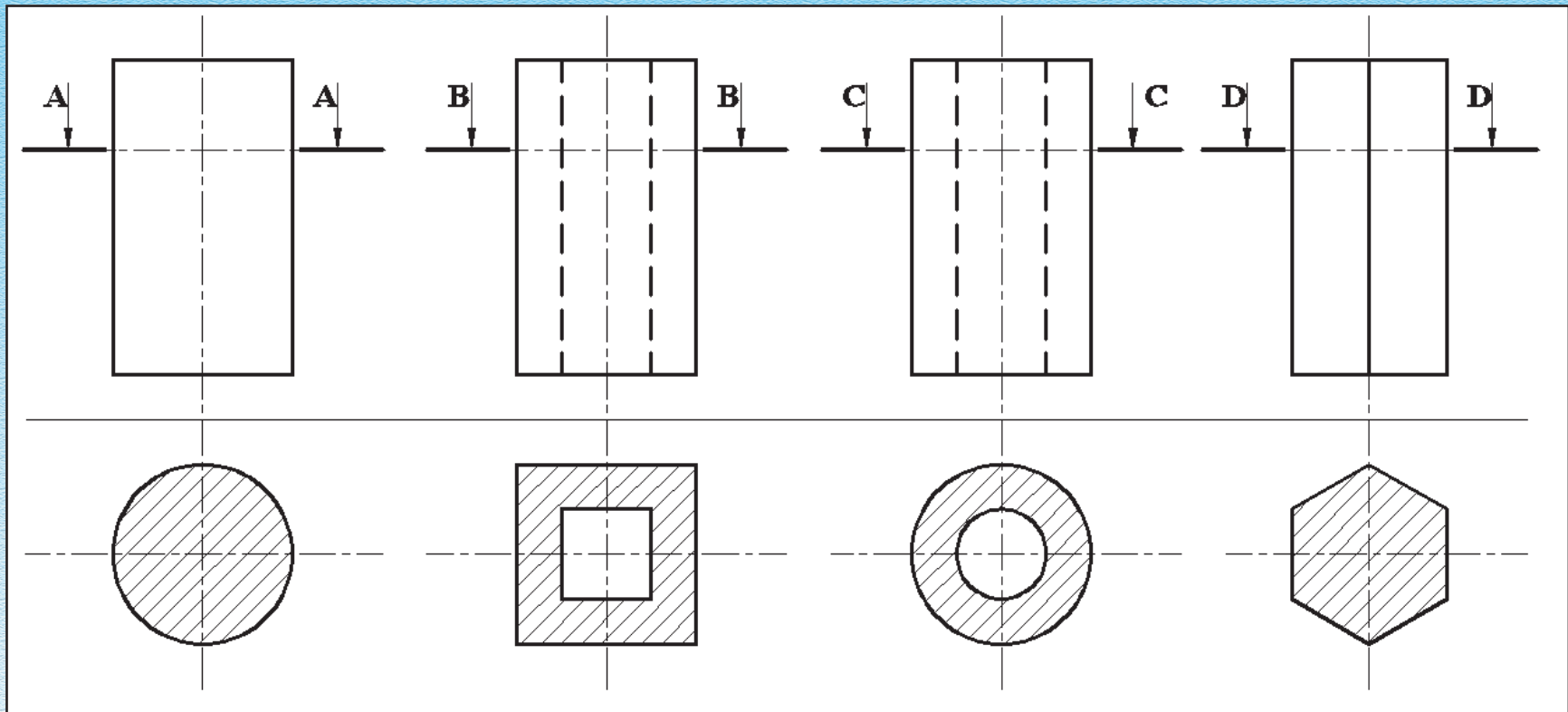


Fig. 5.3 Cross-section of Simple Solids

- It helps in understanding and interpreting the drawings for manufacture of machine parts.

In this chapter, we are going to deal with sections of simple solids which is important to understand the interpenetration of surfaces (where combination of different solids are used to make a machine part).

DO YOU KNOW ?

Various sectioning symbols are used for different materials, as shown (Fig. 5.4) :

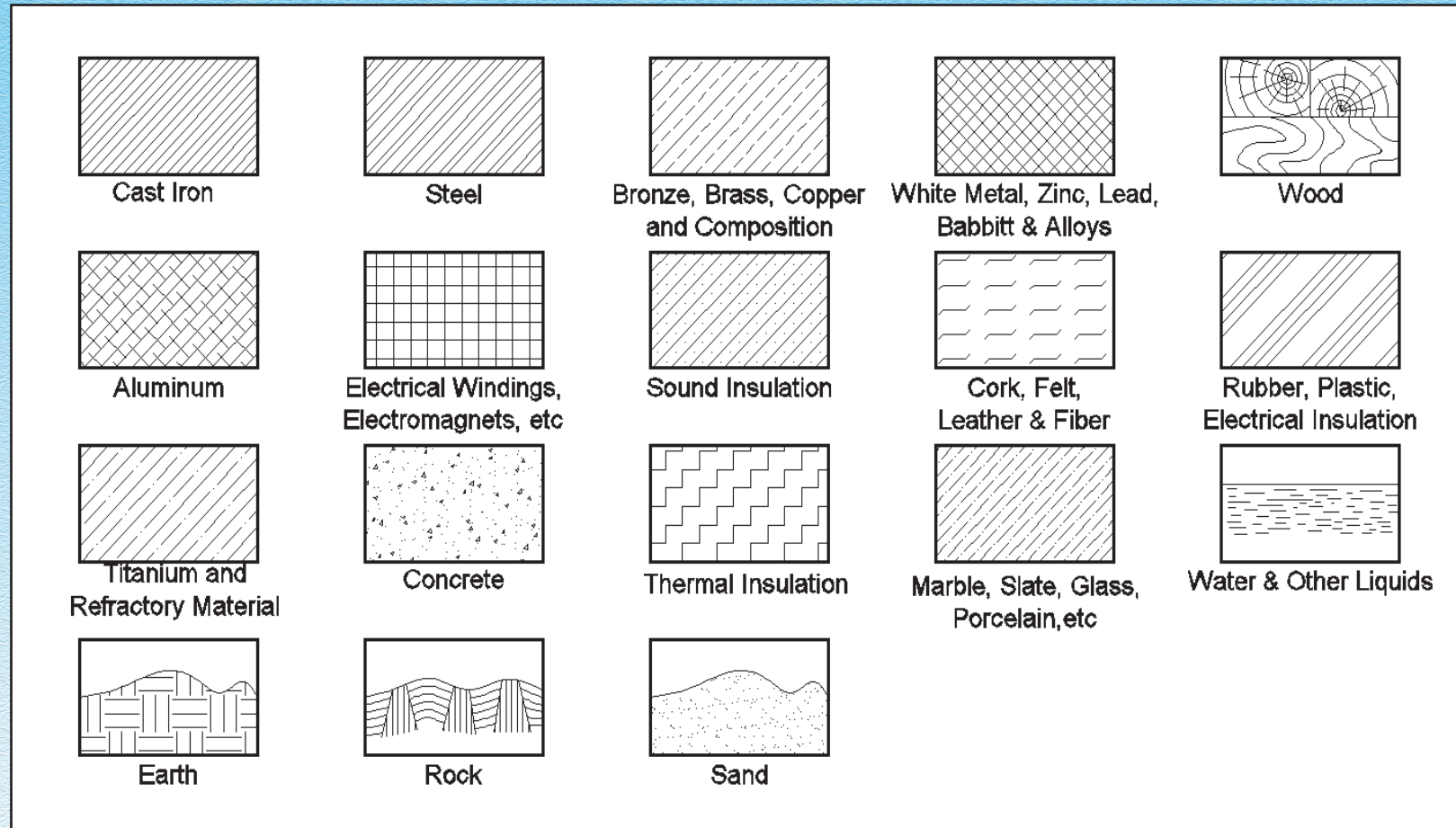


Fig. 5.4

Activity 5.1

Take some vegetables like onion/apple, cucumber/lotus stem, carrot etc. Cut them at different angles and arrange them together to get some of the following shapes (Fig. 5.5)

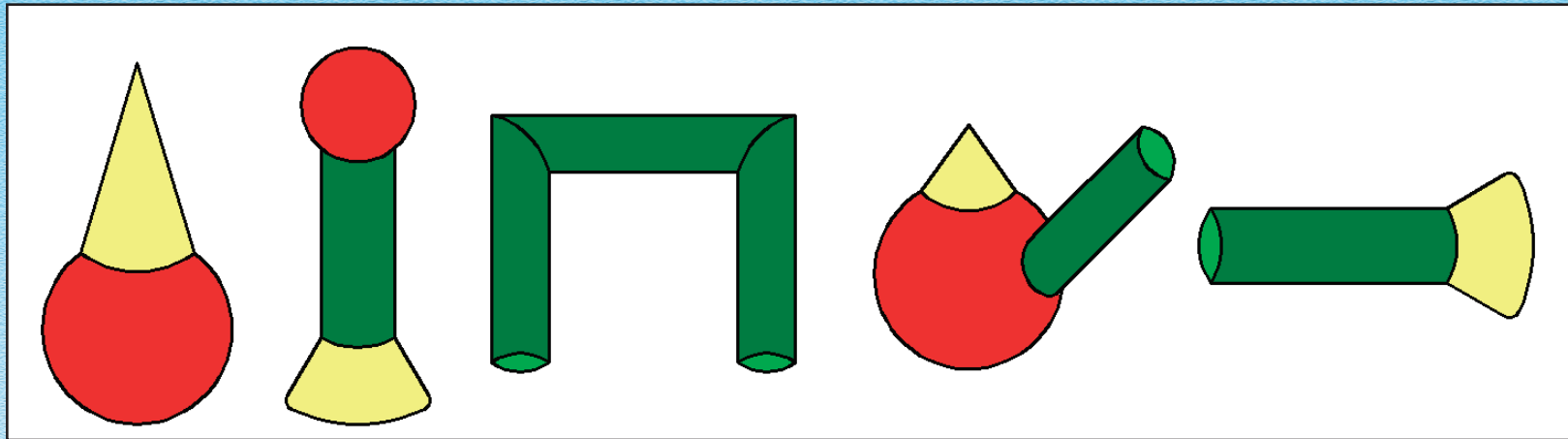


Fig. 5.5

Look around, can you identify some objects which look like a combination of simple cut-solids.

5.2 TERMINOLOGIES AND CONVENTIONS

Now, let us learn more about the terms commonly used while sectioning and the conventions to be followed as per BIS specifications SP-46 : 2003 (Revised)

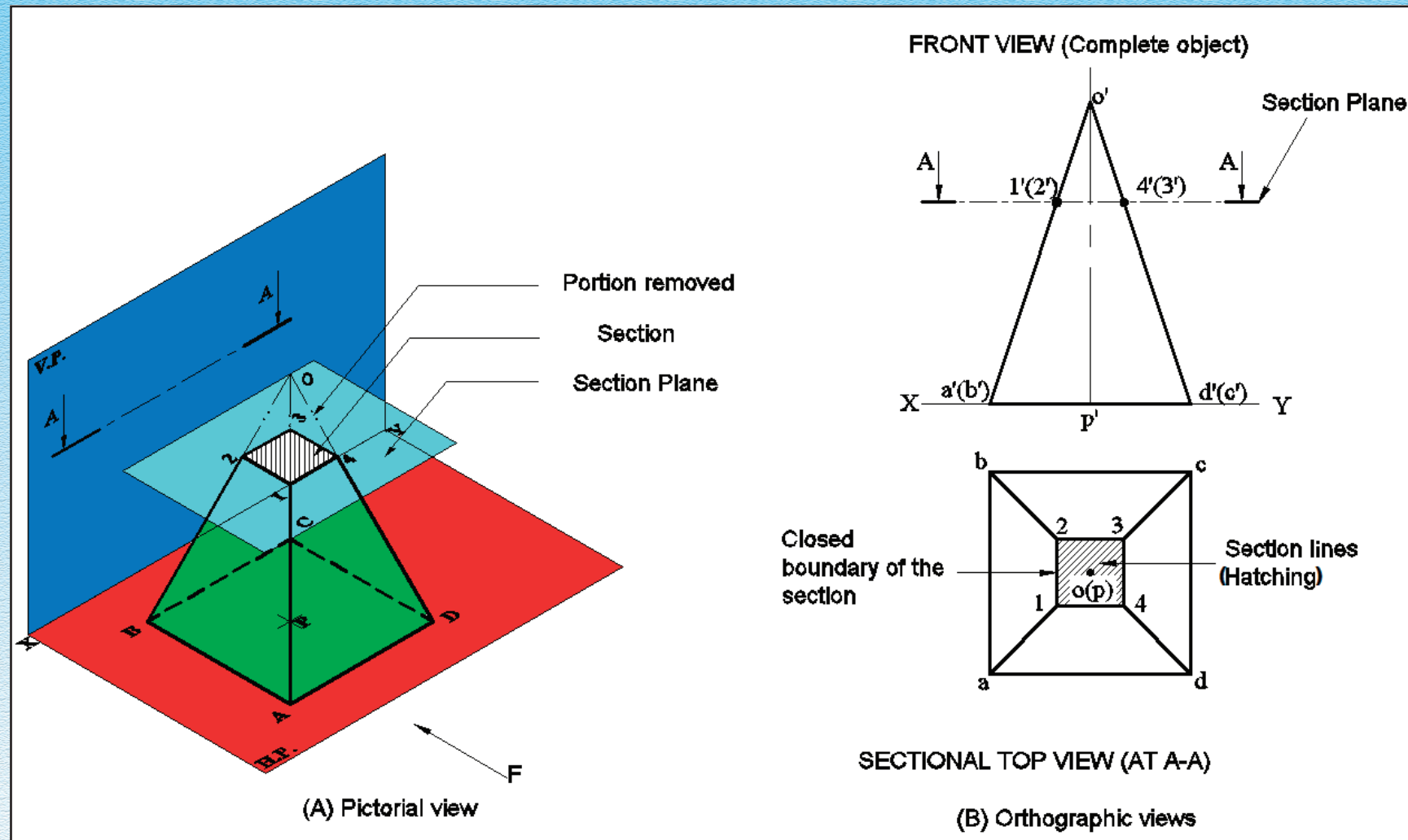


Fig. 5.6

5.2.1 Section Plane/Cutting Plane

As mentioned earlier, this plane indicates where the imaginary cutting takes place, or the path of cutting an object to make a section.

It can also be understood as the path, your knife takes to cut through the apple.

The cutting plane is shown in the orthographic view in Fig. 5.6 (B) where it appears as an edge. This edge is represented as a combination of “Chain Thin” lines as shown clearly in the Fig. 5.7.

The edges of the cutting plane line are terminated by “thick lines” with arrowheads to indicate the direction of viewing the section. It is more completely identified with reference (capital) letters (A-A, B-B etc.) at the beginning and end of the plane. This becomes useful when the object is cut by more than one section plane (Combination of more than one section plane, though rare, is used sometimes to know the details at different positions in a single sectional view).

Note : Section planes are not shown on sectional views.

5.2.2 Sectional view & Section

As mentioned earlier, this orthographic view shows the surface which has been imaginarily cut or exposed, i.e. the section and also shows the remaining portion of the object. It can be identified with the pulp of the apple alongwith its seeds which is visible after it is cut. Fig. 5.6 shows the pictorial as well as the sectional Top (orthographic) view of a square pyramid.

A sectional view generally replaces one of the regular views of the object. To make the cut surface/section seen clearly in the sectional view, it is represented by thin parallel lines (section lines) which will be dealt with later (5.2.3). While drawing sectional views, the following points should be **noted** :

1. The outline of the section is **“continuous thick line”** and **“never represented as hidden lines”**
2. By and large **continuous thick line is not shown** within the section.
3. **Hidden lines are not shown** in the section unless they are needed to describe the object.
4. If a portion of the solid is removed by cutting, then it is represented by **“dashed and double dotted lines”** as shown below (Fig. 5.8).
5. The portion is assumed to be removed only in the sectional view, so other views are full and complete.



Fig. 5.8

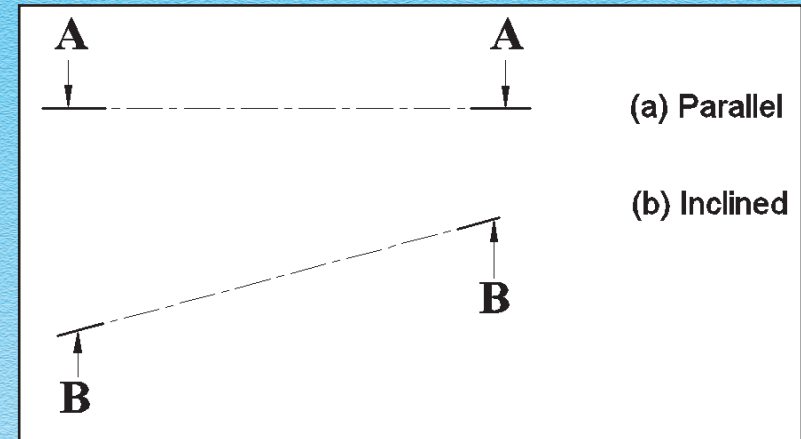


Fig. 5.7

DO YOU KNOW ?

Several types of sections are available for use in explaining the material of the inside parts (fig. 5.9)

The engineer/technician may select from among them, that best describes the shape

- (a) Full section
- (b) Half section
- (c) Revolved / Rotated section
- (d) Removed section
- (e) Local / Partial section
- (f) Offset section, etc.

Some of them will be learnt in the next higher class (XII).

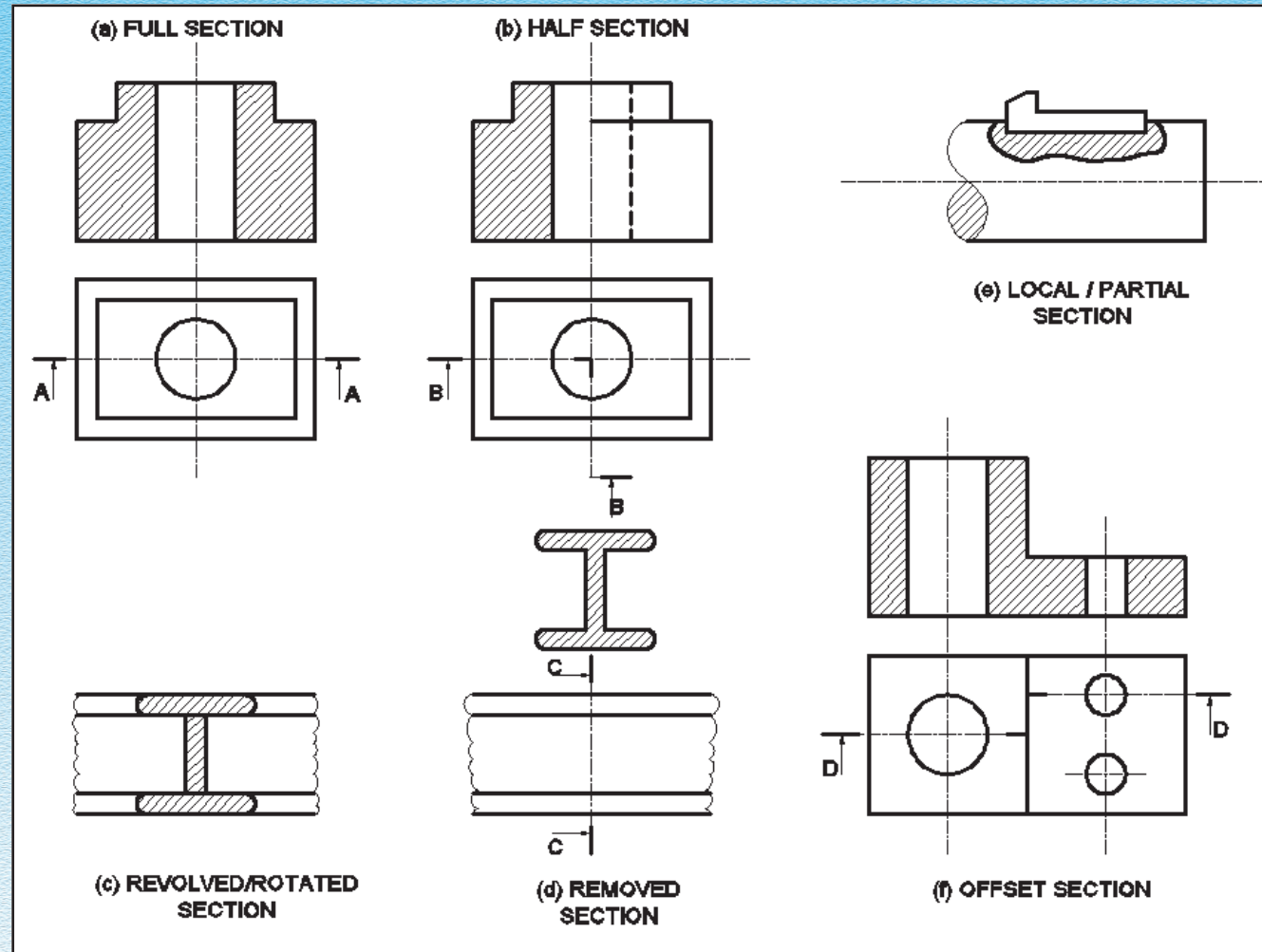


Fig. 5.9

5.2.3 Section Lines

As mentioned previously in (5.2.2), the sectional surfaces are 'hatched', i.e. continuous thin parallel lines are drawn with equal spacing, (say 1-3 mm), minimum being 0.7 mm as per BIS SP : 46 – 2003 (Revised) specification. These lines are called as "**section lines**". They are drawn at 45° to the "**principal outlines**" or "lines of symmetry of the sections", as shown in the Fig. 5.10

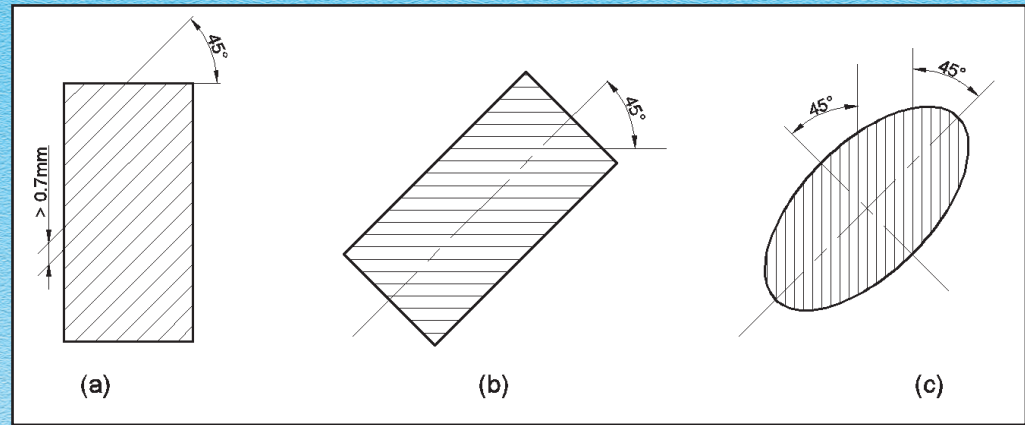


Fig. 5.10

While hatching the **following points** should be taken care of :

1. Hatching shall be interrupted when it is not possible to place inscriptions (i.e. dimensions or text), outside the hatched areas as shown in the Fig. 5.11 below:

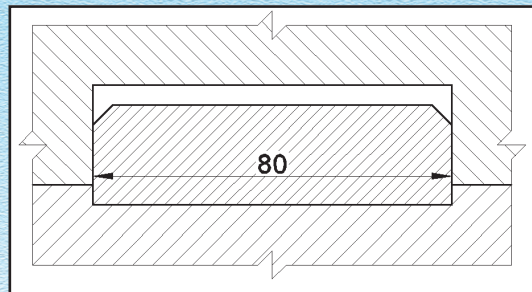


Fig. 5.11 No Hatching over text/dimensions

2. Separate areas of a section of the same component shall be hatched in an identical manner. Various ways of hatching are shown in Fig. 5.12. Adopt the correct method for a neat, precise and clear drawing.

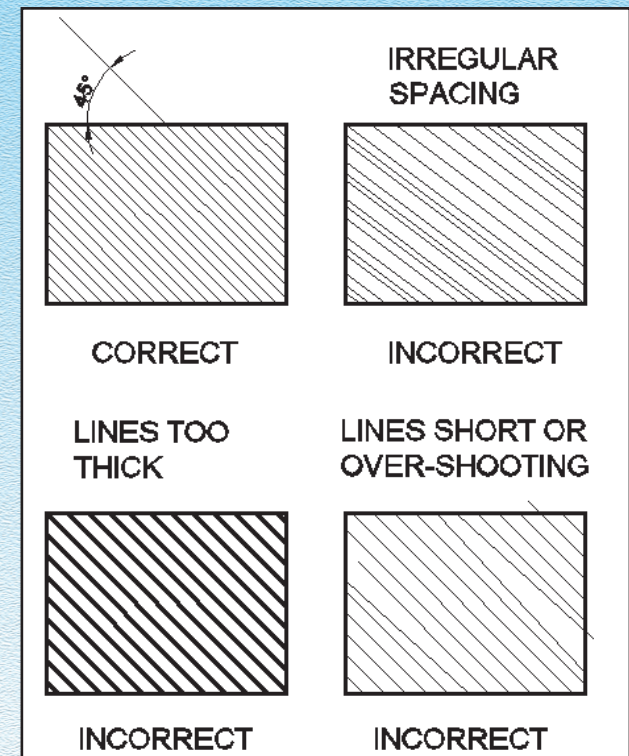


Fig. 5.12 Correct & Incorrect Methods of Hatching

ACTIVITY 5.2

Make clay/plasticine models (out of soap cakes) of simple solids (prisms, pyramids, cylinder etc.) as learnt in previous chapter. Paint them from outside.

Cut them horizontally or vertically or at some angle. The section surface will be visible clearly. Try to sketch these sections.

(These models can be used to understand the examples which will be explained later in this chapter).

TRY THESE

- I. What is sectioning ?
- II. Give two examples, where sectioning is used.
- III. Fill in the blanks, from these alternatives (45°, 60°, sectional, cutting)
 - (a) The plane is shown as 
 - (b) In view, the portion of the object between section plane and the observer is assumed, to be removed.
 - (c) The Hatching lines are generally drawn inclined to the horizontal at an angle of

Having learnt the basic concepts & techniques let us take up the drawing/construction of sectional views. In this chapter, we are going to deal with sections of simple solids, (the ones studied in the previous chapter)

5.3 DRAWING TECHNIQUES FOR SECTIONAL VIEWS

Drawing of these views is an extension of projection of solids. Hence, the procedure explained in the previous chapter is followed here also. To understand the basic technique, let us consider the example of a square pyramid which is cut by a horizontal section plane as shown in Fig. 5.6.

Steps of Construction : Refer to Fig. 5.13

1. Refer to Fig. 5.13 (1) Draw the projections of the complete solid in the required position using thin lines (as learnt in the previous chapter). Name the base and points of the axis. In this case, square base a-b-c-d- and axis points o-p. Project these points in the other view (here, Front View)
2. Refer to Fig. 5.13 (2) Mark the given section plane in the appropriate view (i.e. Front View in this case) as a line. Name the points of intersection (POIs) of this plane with the edges (base, rectangular/slant) drawn in the view. So, we have points 1', 2', and 3', 4' cutting the slant edges o'-d, o'-a' & o'-c', o'-b' respectively in Front View.

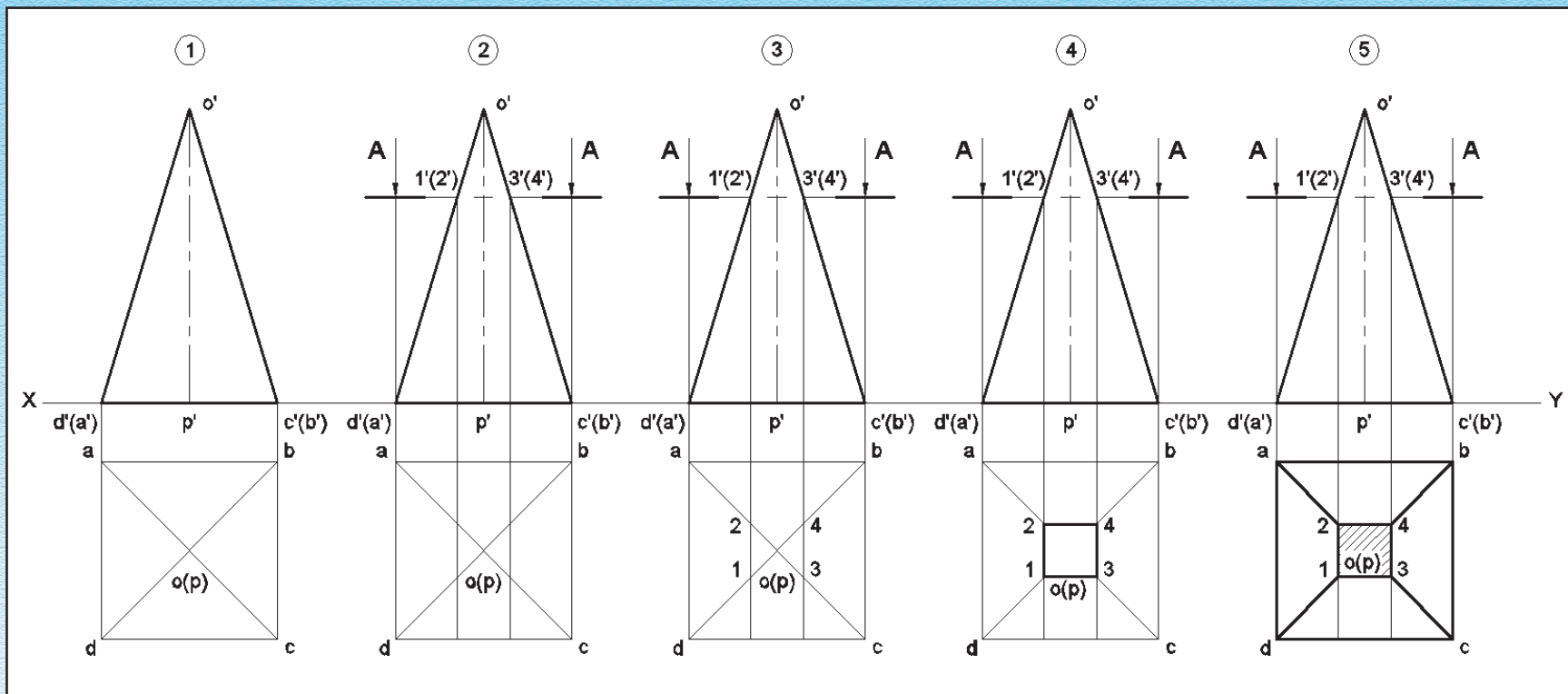


Fig. 5.13 Step wise Drawing Procedure

3. Refer to Fig. 5.13 (3) Project these points of intersection, (POIs) on the other view (here Top View) by identifying the corresponding edges they cut. So point 1 cuts o-d, pt. 2 cuts o-a and so on in the Top View.

4. Refer to Fig. 5.13 (4) Join the projected points to form the boundary of the sectioned surface with continuous thick lines.

(Note : A flat surface cut by a plane, gives a straight boundary, while a curved surface cut by a plane, gives a curved boundary in the sectional view).

5. Refer to Fig. 5.13 (5) Complete the drawing of the remaining portion with continuous thick lines.

(Note : In case a portion of the solid is removed and it lies outside the section, then it is represented by "dashed and double dotted line")

5.3.1 Types of Sectional Views

The sectional views so obtained can be either of two types :

1. Sectional Front View
2. Sectional Top View

5.3.1.1 Sectional Front View

As the name suggests, the section is seen in the Front View. This is possible when the **section plane is vertical/inclined to the vertical** i.e. perpendicular to HP and parallel to VP or it is inclined to the vertical plane (VP) as shown in Fig. 5.14.

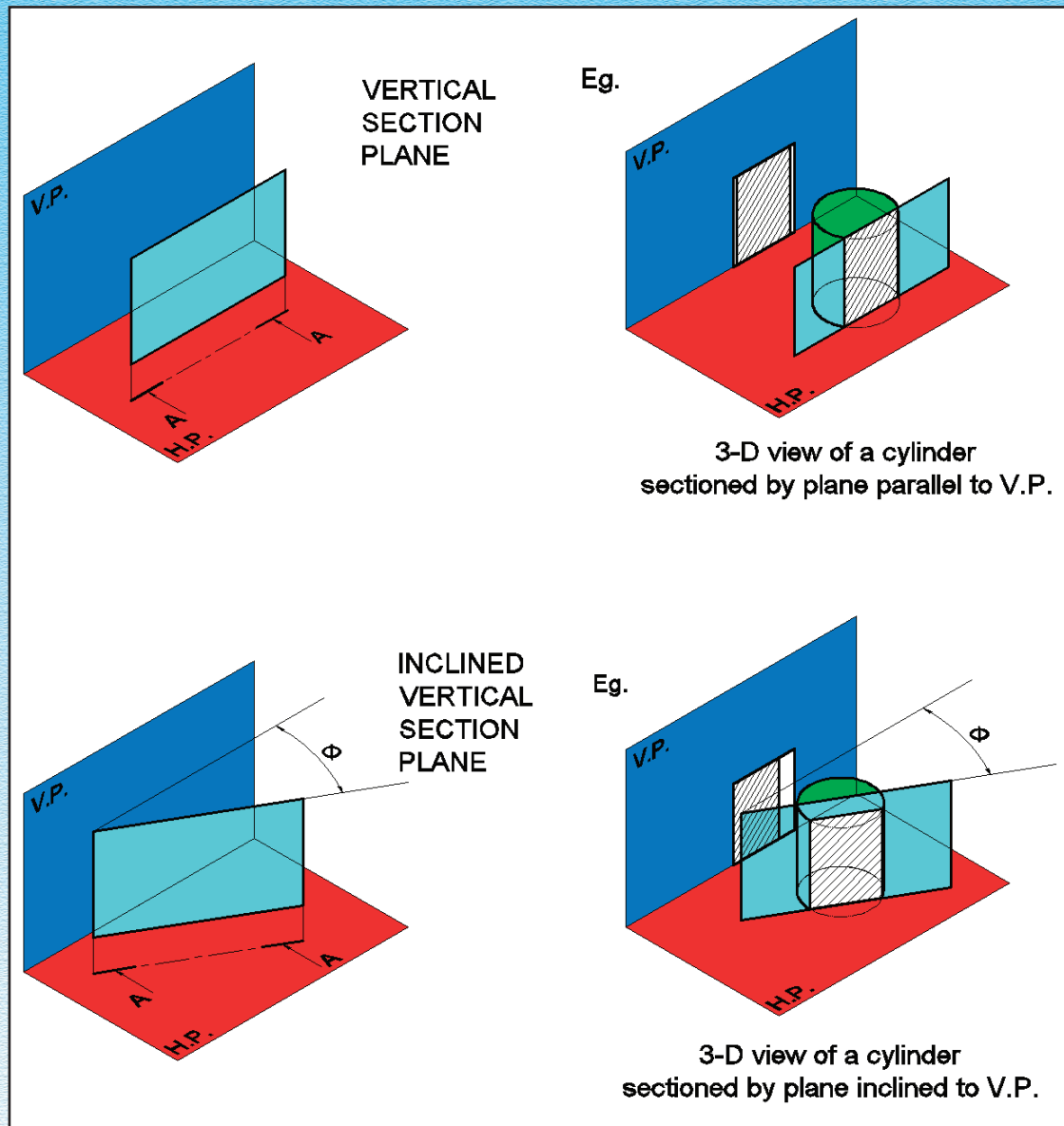


Fig. 5.14

5.3.1.2 Sectional Top View

Similarly, here, the section is seen in the Top View. That is, the section plane is horizontal/ inclined to the horizontal i.e. perpendicular to VP and parallel to HP or it is inclined to the horizontal plane (HP) as shown in Fig. 5.15.

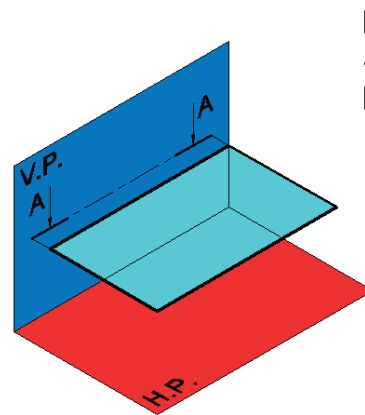
5.3.2 : Examples

Let us consider some examples to understand construction of sectional views, as well as differences in developing them according to different cases.

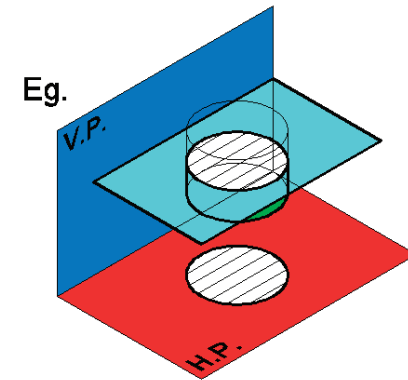
5.3.2.1 Section Plane Parallel to HP & Perpendicular to VP.

As suggested in (5.3.1.2), the section plane is represented as a line in the "Front View" and the sectional view is obtained in the Top View.

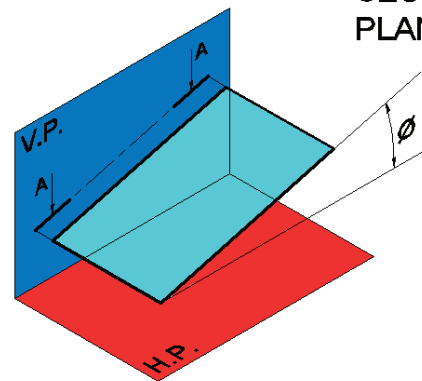
Example 5.1 : A cube of 40 mm side is cut by a horizontal section plane, parallel to HP at a distance of 15 mm from the top end. Draw the sectional Top View and the Front View.



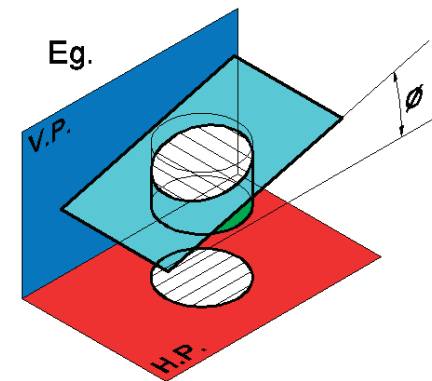
HORIZONTAL
SECTION
PLANE



Eg.
3-D view of a cylinder
sectioned by a plane parallel to H.P.



INCLINED
HORIZONTAL
SECTION
PLANE



Eg.
3-D view of a cylinder
sectioned by a plane inclined to H.P.

Fig. 5.15

Solution : Refer to fig. 5.16 (a)

1. Draw the Top View and Front View as shown.
2. In the Front View, draw the section plane parallel to X - Y line (HP) at a distance of 15 mm from the top edge $a'1'-d'1'$.
3. Locate points of intersection (POIs), pts. 1', 2', 4' & 3' cutting edges $a'a'1'$, $b'b'1'$, $c'c'1'$ and $d'd'1'$ as shown pictorially in Fig. 5.16(b)
4. Project these pts. on their corresponding edges in the Front View. (Here they are the corners of the square itself.)
5. The pts. 1, 2, 3, 4 are already joined. Now hatch the area.

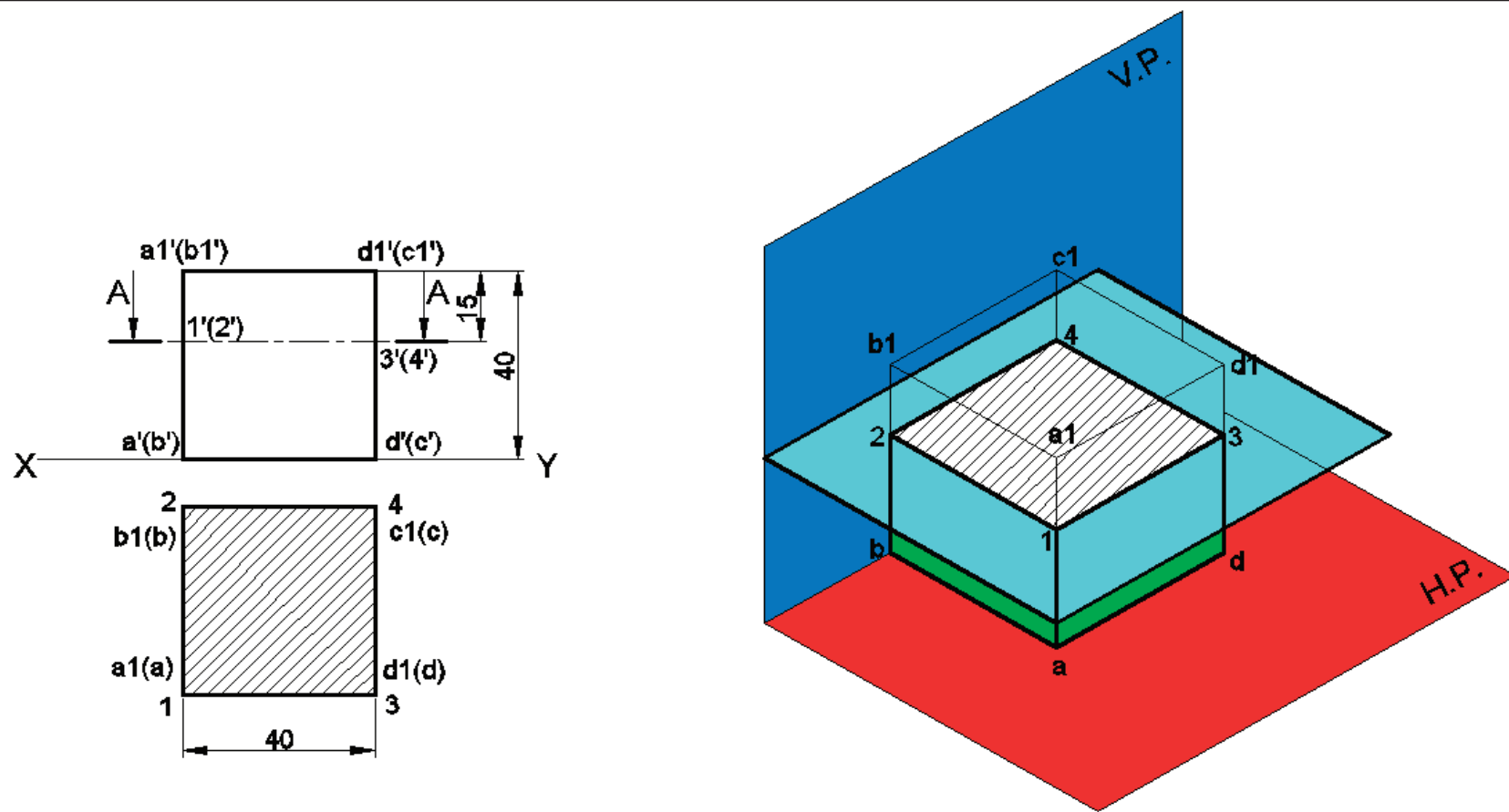


Fig. 5.16

Example 5.2 : A triangular prism with base side 40 mm and length of axis = 65 mm is resting on its rectangular face on HP with axis perpendicular to V.P. The prism is cut by a horizontal section plane, 20 mm distance above the ground. Draw the Front View and sectional Top View.

Solution : Refer to fig. 5.17 (a)

1. Draw the Front View and Top View as shown in the given position.
2. In the Front View, draw the section plane B-B at a distance of 20 mm from X-Y line and parallel to it.
3. Locate the POIs pt. 1' cutting front edges a'b' and the edges of the triangular face at the back at 2'. Similarly 3' and 4'.
4. Project these pts. on their corresponding edges in the Top View. as shown in Fig. 5.17 (a)
5. Join the pts. 1, 2, 4, & 3 and hatch the area.

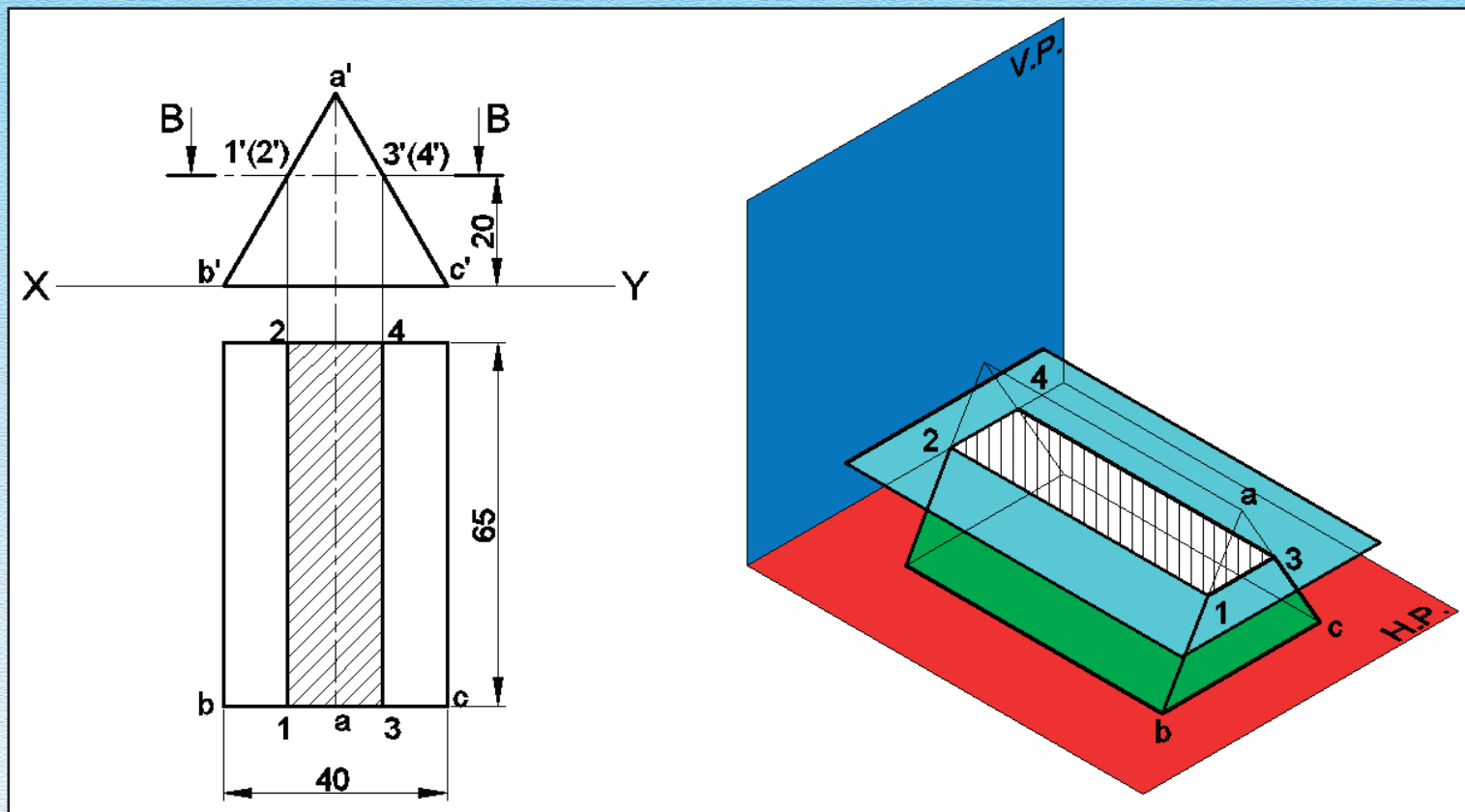


Fig. 5.17

Example 5.3 : A hexagonal pyramid is resting on its base on the ground with two of its base edges of length 30 mm, parallel to HP. A horizontal section plane, bisects the 80 mm long axis. The axis is perpendicular to H.P. Draw the Front View and sectional Top View.

Solution : Refer to Fig. 5.18

1. Draw the Front View and Top View as shown in the given position.
2. In the Front View, draw the section plane B-B passing through the mid-point of the axis $O'O_1'$ as shown.
3. Locate the POIs $1', 2'-3', 4'-5', 6'$ cutting the edges $o'a', o'b', o'f', o'c', o'e'$ & $o'd'$ respectively.
4. Project these pts. on their corresponding edges in the Top View.
5. Join the pts. 1,3,5,6,4,2 to form the outline of the section and hatch the area.

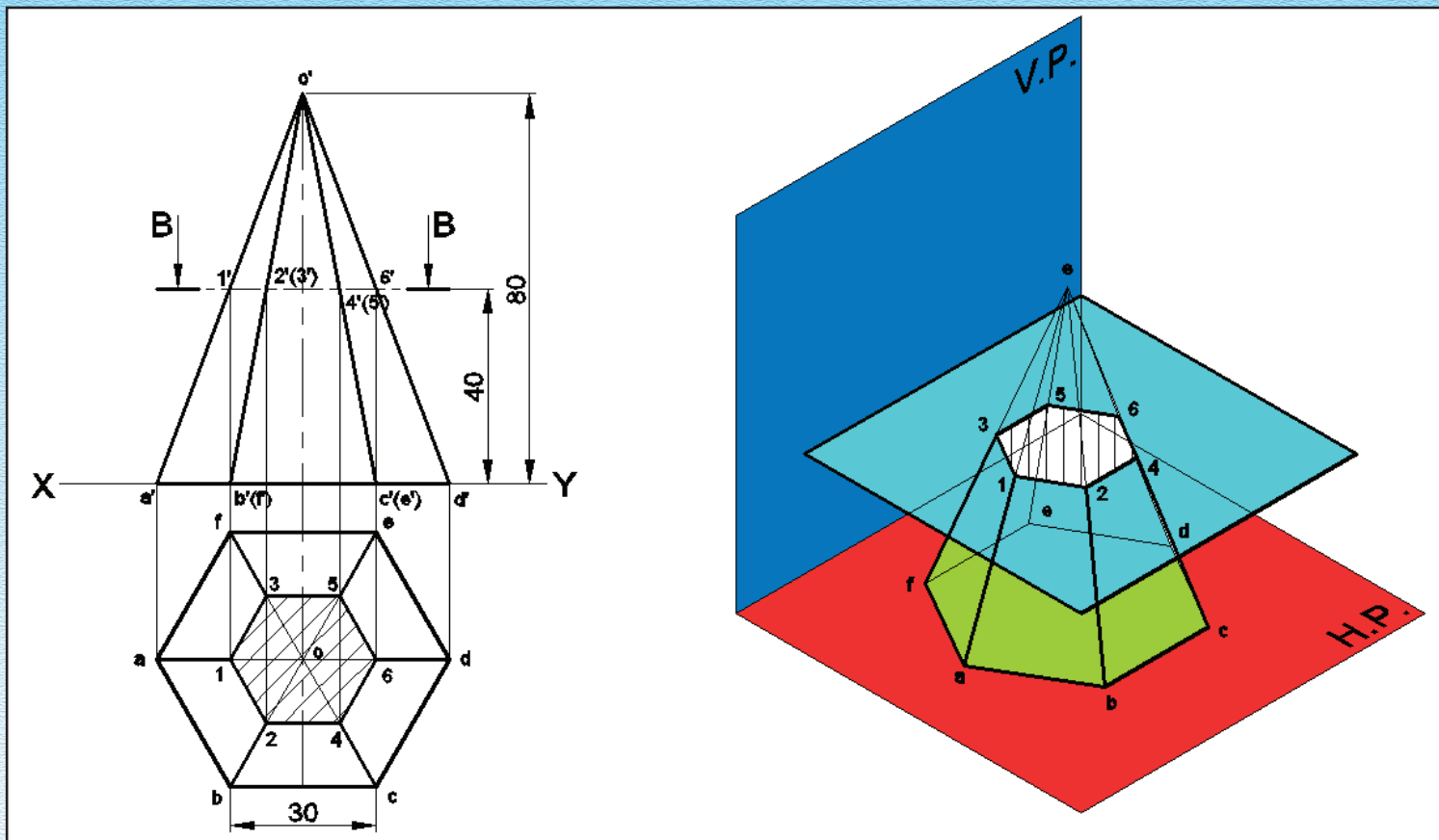


Fig. 5.18

5.3.2.2 Section Plane Inclined to HP and $\perp$ to V.P.

Example 5.4 : A square prism of base side 50 mm and height of axis 80 mm has its base on HP. It is cut by a section plane perpendicular to V.P. and inclined to HP such that it passes through the two opposite corners of the rectangular face in front. Draw the sectional Top View and Front View. Find the angle of inclination of the section plane.

Solution : Refer to fig. 5.19

1. Draw the Front View and Top View as shown
2. As section plane is inclined to HP, draw line E-E in Front View meeting corners e' and d' making an angle θ with X-Y line (HP). Find angle θ
3. Locate the POIs $1' - 2', 3' - 4'$ cutting edges/corners $e', f', d' & c'$ respectively.
4. Project these pts. in the Top View.
5. Join these pts. to form the outline and hatch the area.

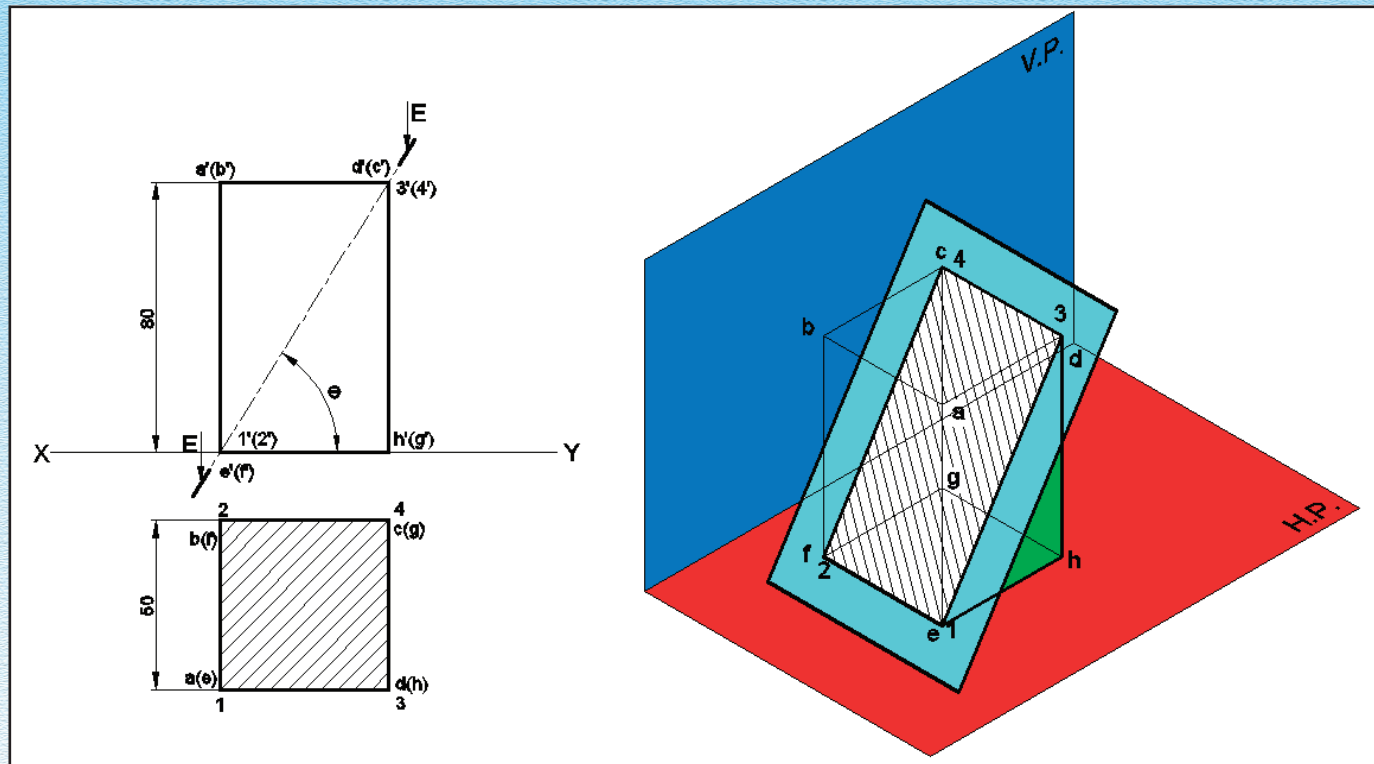


Fig. 5.19

Example 5.5 : A cylinder of base diameter 50 mm and height 70 mm is resting on its curved surface on HP such that the axis is normal to VP. A section plane inclined to HP at an angle of 60° , passes through the axis and cuts the solid into two halves. Draw the Front View and sectional Top View.

Solution : Refer to fig. 5.20

1. Draw the projections of the solid as shown.
2. In the Front View, draw the section plane F-F making an angle of 60° with X-Y line and passing through the centre.
3. Locate the POIs 1', 2', 3', 4' in Front View cutting the circular faces as shown pictorially in Fig. 5.20 (b).
4. Project these pts. on their corresponding edges in the Top View.
5. Join these points 1'-2'-4'-3' and hatch the area.
6. Draw the remaining portion. In this case, some portion of the solid is removed and lies outside the section, so it is represented by "dashed and double dotted lines."

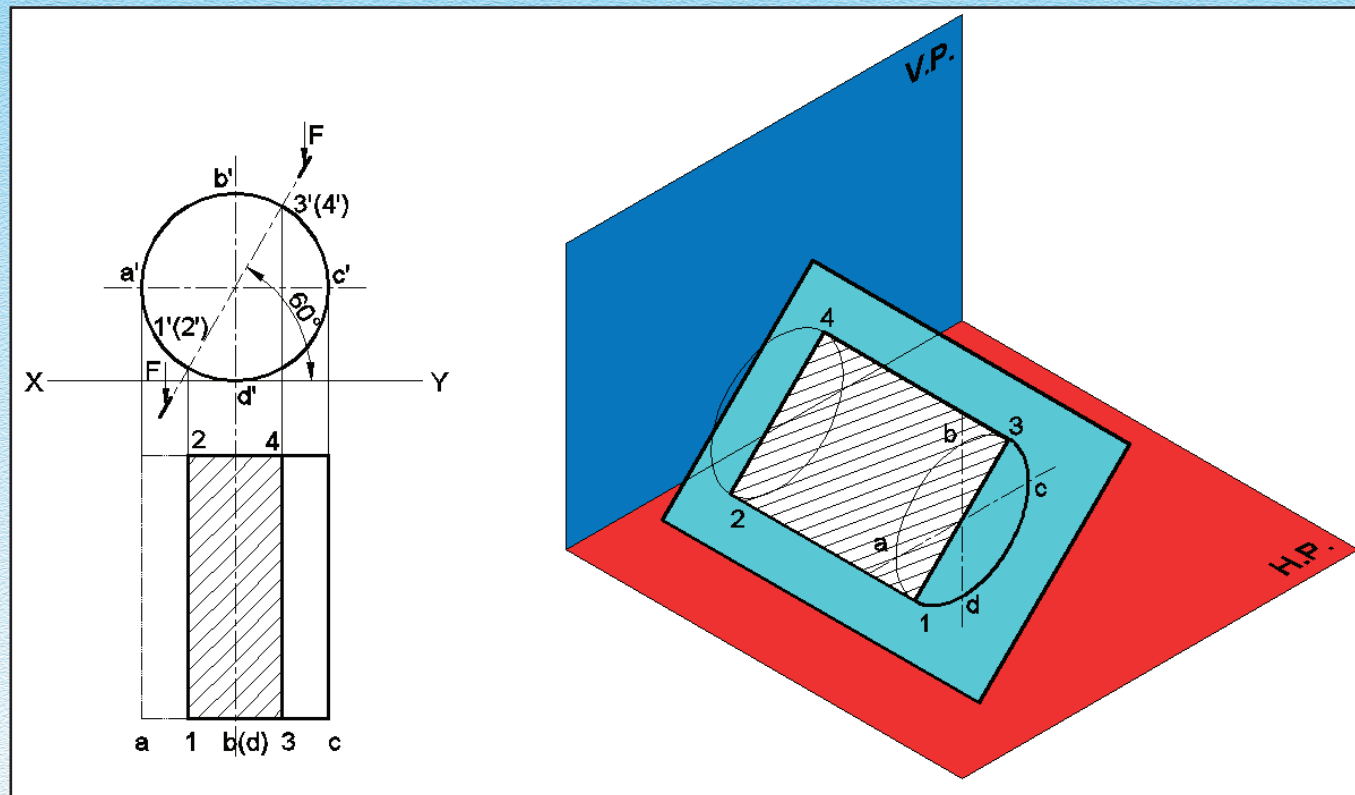


Fig. 5.20

Example 5.6 : A triangular pyramid is resting on one of its base corners on the ground, such that its 30 mm base side on top is parallel to HP. Its 65 mm long axis is $\perp$ to V.P. It is cut by a section plane perpendicular to V.P. and inclined to HP at 60° such that it bisects the top base edge. Draw the Front View and sectional Top View

Solution : Refer to fig. 5.21

1. Draw the Front View and Top View in the given position as shown.
2. Draw line G-G in the Front View meeting the midpoint of edge 'a-b' and inclined at 60° to HP.
3. Locate the POIs 1' 2', 3' cutting edges a'-c', o'-a' & a'-b' respectively.
4. Project these pts. on their corresponding edges in the Top View.
5. Join pts. 1, 2, 3 and hatch the area.
6. Draw the remaining portion as mentioned in the earlier e.g. to get the sectional view.

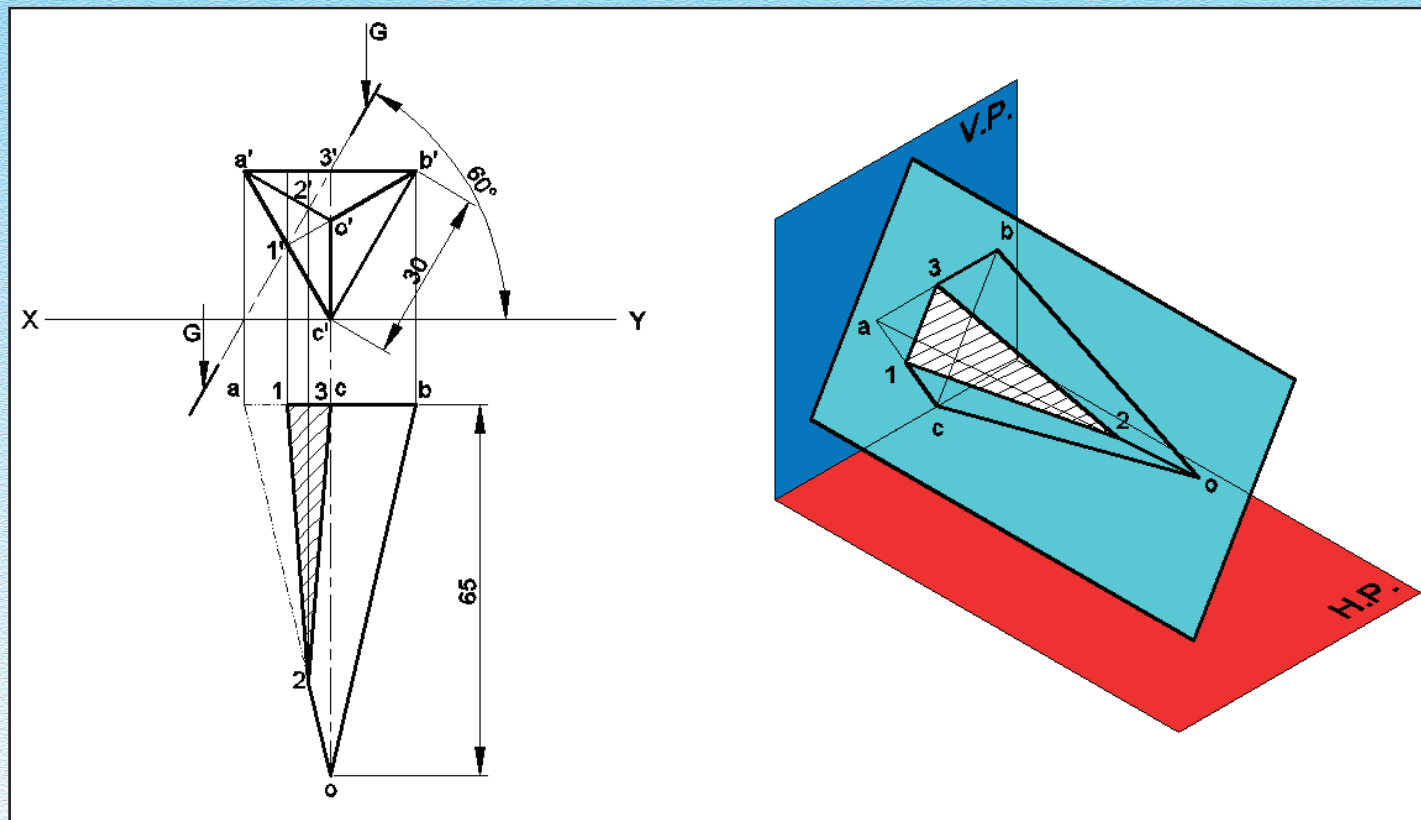


Fig. 5.21

Example 5.7 : A vertical pentagonal pyramid is lying on its base on HP with one of its 45 mm long base edge at the rear parallel to V.P. It is cut by a section plane inclined at 60° to HP and bisects the axis. The axis measures 80 mm. Draw the Front View and sectional Top View.

Solution : Refer to fig. 5.22

1. Draw the Front View and Top View in the given position as shown.
2. Draw section plane F-F inclined at 60° to X-Y and meeting axis line $o'e'$ at a distance of 40 mm (midway) from X-Y line.
3. Locate the POIs $1', 2', 3', 4', 5'$ & $6'$ cutting the base edges $a'e'$ & $a'b'$, the slant edges $o'b'$, $o'e'$, $o'c'$ & $o'd'$ respectively.
4. Project these pts. on their corresponding edges in the Top View. (But it can be seen that point $4'$ can't be projected vertically on the edge $o'e'$)
5. So we have an extra step, i.e. draw a line parallel to the base from pt $4'$ in the Front View, meeting one of the other slant edges at pt. $7'$. Then project pt. $7'$ in the Top View on the edge od . From pt. 7 in the Top View, draw a line parallel to the base meeting the edge oe at the desired pt. 4 .
6. Join the pts. 1, 2, 3, 5, 6, 4 and hatch the area.
7. Draw the remaining portion and complete the view.

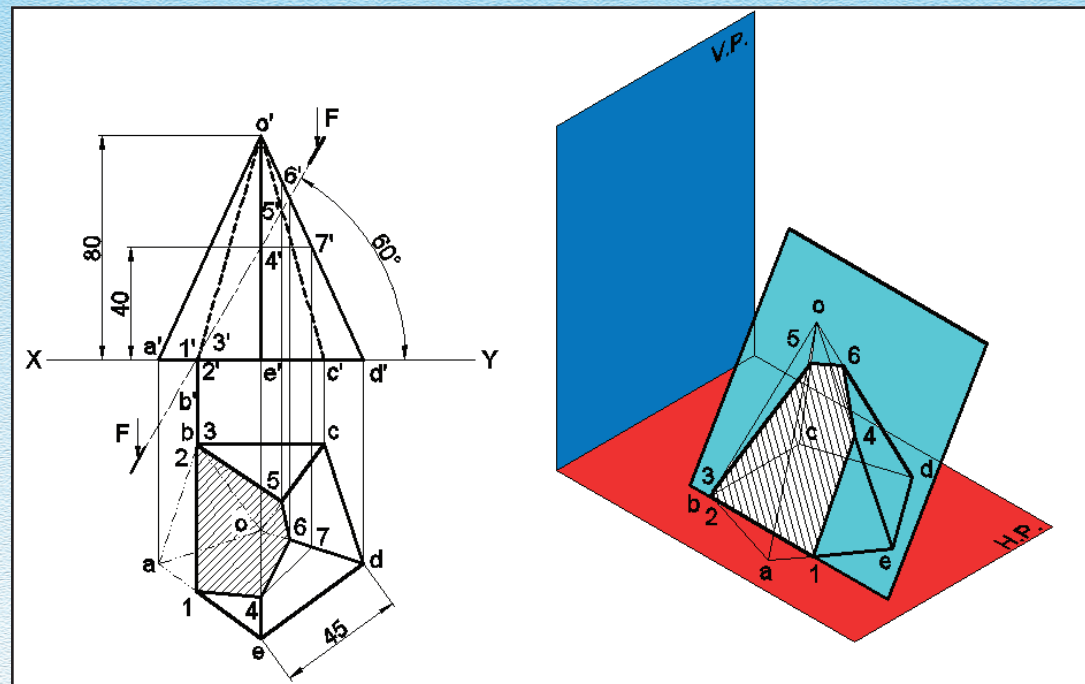


Fig. 5.22

Example 5.8 : A cone of ϕ 60 mm base and axis of length = 80 mm is resting on its circular face on H.P. It is cut by a section plane inclined at 60° to HP and meets the axis at a point 30 mm below its apex. Draw the sectional Front View and Top View.

Solution : Refer to fig. 5.23

1. Draw the Top View and Front View as shown.
2. Mark a point, 30 mm below apex o' in the Front View and draw a 60° inclined section plane D-D passing through it.
3. Locate POIs $1'$ & $2'$, meeting generators $o'a'$ & $o'b'$, in Front View and project them in the Top View on diameter a-o-b. (It can be seen that they don't have edges & more points need to be located to get the shape of the section)
4. Hence, divide the section plane into equal parts say 4 pt. and draw lines parallel to the base passing through these points These lines represent Circle A, B & C and their respective POIs with section plane are $3'-4'$, $5'-6'$ & $7'-8'$.
5. Find the width of the lines draw in the earlier step and taking them as diameters, draw circles A, B & C in the Top View.
6. Project the POIs in the Top View, meeting the circles A, B & C at points 4, 3; 6, 5 & 8, 7 respectively.
7. Join pts. 1, 4, 6, 8, 2, 7, 5, 3 as a curve. (As in this case, the section plane is cutting a curved surface.) Section the area.

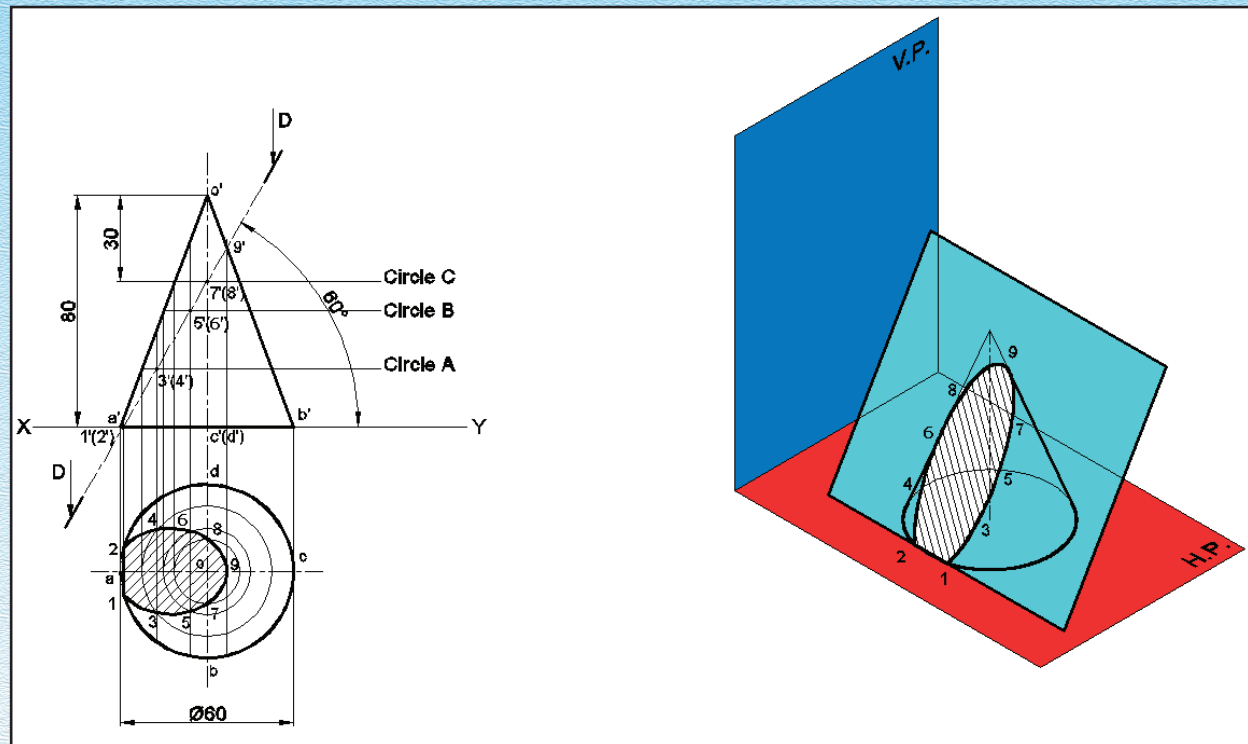


Fig. 5.23

Example 5.9 : A sphere of 32 mm diameter is cut by a horizontal section plane inclined at 45° to the HP and at a distance of 8 mm from O the centre. Draw the Front View & sectional Top View.

Solution : Refer to Fig. 5.24

1. Draw the projections of the given sphere.
2. Draw the inclined section plane A-A in the Front View which is tangential to a circle A' of 8 mm radius.
3. Locate Pts. 1' & 2' meeting the outer circle as shown and project them in the Top View on the line 0-01 which represents the outer circle (circle D). It can be seen that some more points need to be located to get the shape of the section. Hence draw circles of any radii between the inner-most (circle A') and outermost (Circle D'), at suitable distance i.e. circle B' & C' respectively. Project these circles as lines in the other view as shown.
4. Locate POIs on these constructed circles in the Front View, i.e. 3', 4', 5', 6', 7', 8', 9', 10', 11', 12' meeting circles C', B' and A' in Top View.
5. Project these POIs on the respective lines representing these circles in the Top View i.e. Pts. 1, 2 on circle D, pts. 3, 11, 4 & 12 on circle C and so on Join these pts. as a curve as a curved surface is cut a section plane and draw section lines.
6. Draw the remaining portion of the solid.

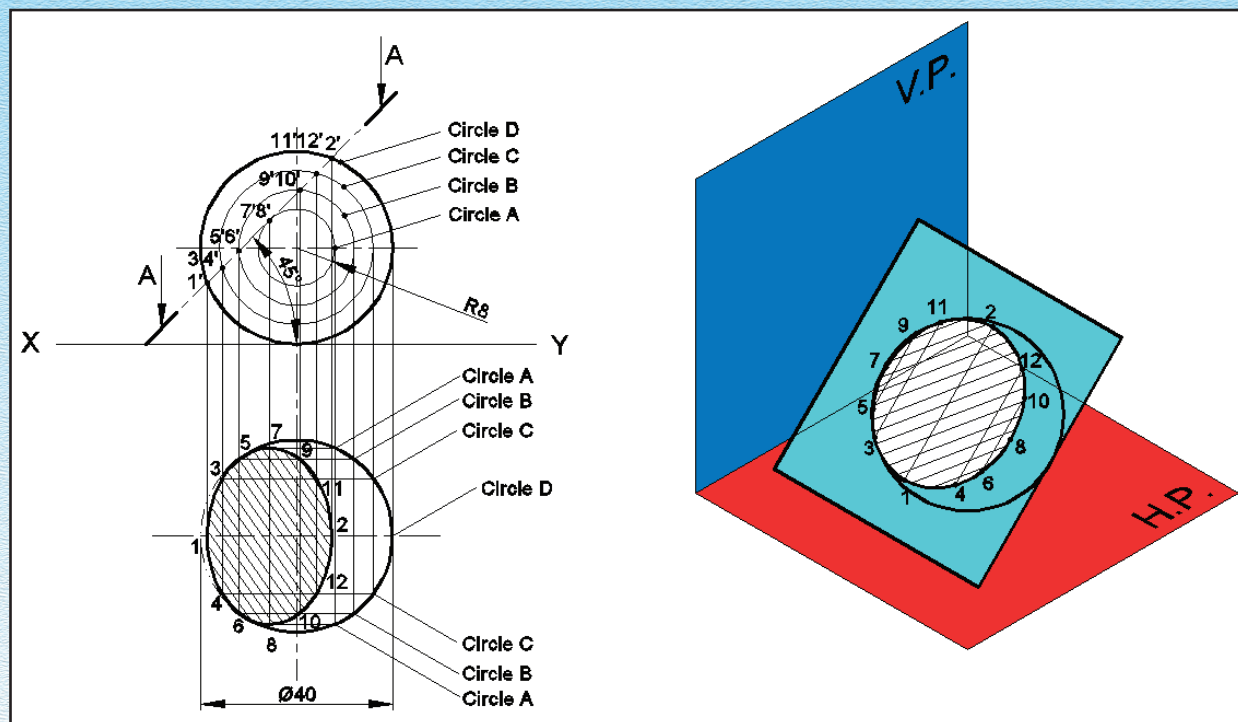


Fig. 5.24

TRY THESE

1. A Front View of a regular hexagonal pyramid is cut centrally by a section plane A-A. Complete the Top View and draw the section Fig. 5.25(a).
2. A Top View and an incomplete Front View of a square prism are shown in Fig. 5.25(b). The prism is cut by a 45° inclined section plane at a distance of 20 mm from one of the corners. Draw the given Front View, complete the Top View and add the section.
3. A pentagonal prism of length 60 mm is shown resting on HP in Fig. 5.25 (c) which is cut by section plane C-C parallel to HP at distance of 10 mm from top most long edge. Draw the given Front View, and add the sectional Top View.

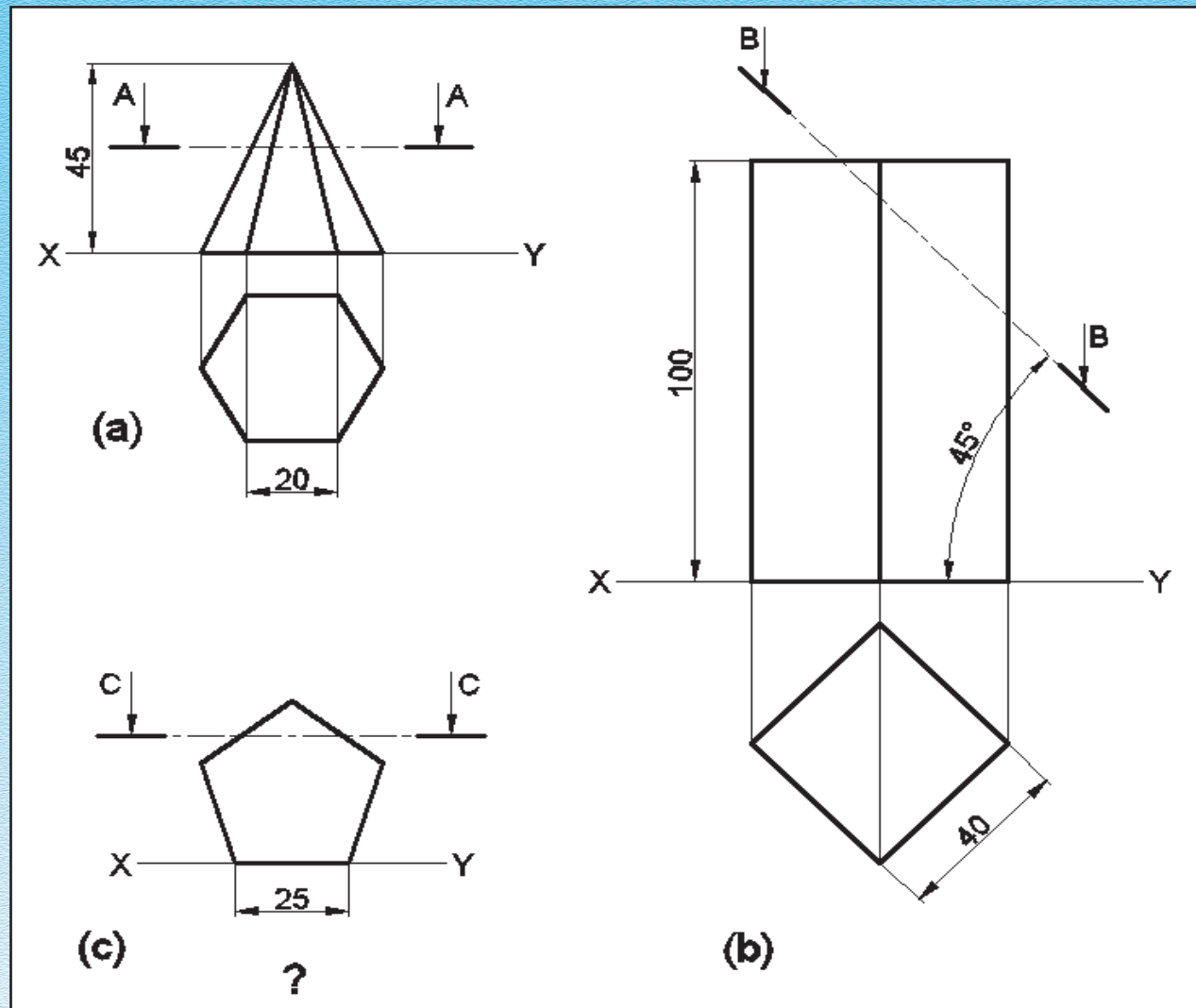


Fig. 5.25

5.3.2.3 Section Plane Parallel to VP & Perpendicular to HP

Similarly, here the section plane is represented as a line in the "Top View" and the sectional view is obtained in the Front View.

Example 5.10 : A sphere of 40 mm dia is cut by a vertical section plane, which passes through it at a distance of 10 mm from its centre. Draw the sectional Front View & Top View.

Solution : Refer to Fig. 5.26

1. Draw the projections.
2. Draw the section plane A-A at a distance of 10 mm from the centre o in the Top View as shown.
3. Locate the POIs 1, 2 in the Top View intersecting the circle. As only two points are not enough in case of section of curved surface. Hence locate two more POIs 3 & 4 meeting the axis line.
4. Project these POIs in the Front View and draw a circle with centre o' and dia $1' - 2'$ equal to section line 1-2 in the Top View.
5. Draw section lines to get the sectional Front View.

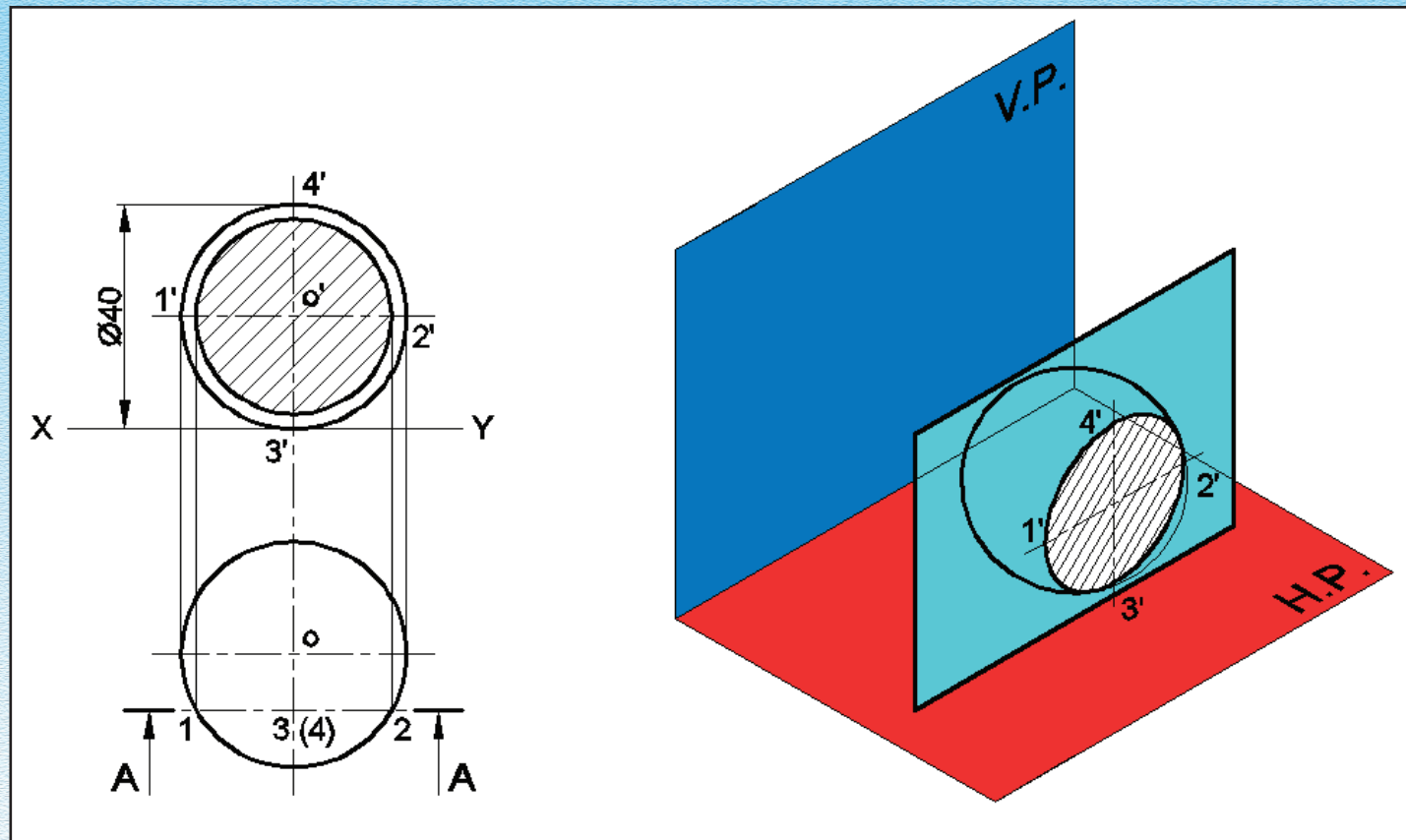


Fig. 5.26

Example 5.11 : A square prism with 30 mm base side and length of axis = 80 mm is resting on its base on HP such that all the vertical faces are equally inclined to VP. A section plane parallel to VP and perpendicular to HP, and 10 mm away from the axis, cuts the prism. Draw Top View and sectional Front View.

Solution : Refer to Fig. 5.27

1. Draw Top View and Front View of the prism as shown.
2. In the Top View, draw the section plane D-D parallel to X-Y line and at a distance of 10 mm away from the centre o.
3. Locate POIs 1, 2, & 3, 4 in Top View intersecting edges, a-b, a₁-b₁, b-c & b₁-c₁
4. Project these POIs on their corresponding edges in Front View.
5. Join 1'-2'-4'-3' and section the area.

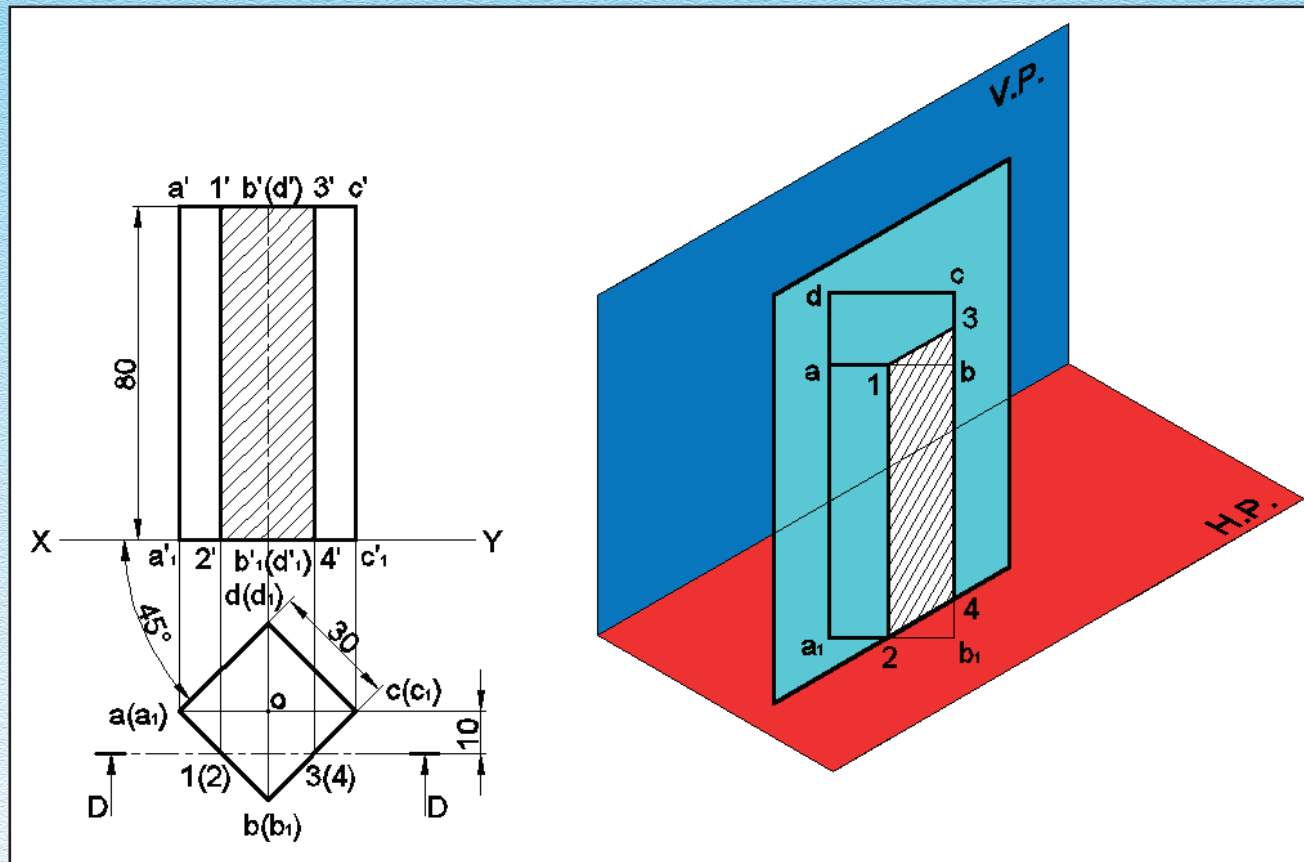


Fig. 5.27

Example 5.12 : A cone of base dia 40 mm is resting on HP and its 50 mm long axis $\perp$ to HP. It is cut by a section plane $\perp$ to HP and parallel to VP, at a distance of 10 mm from the front. Draw the Top View and sectional Front View.

Solution : Refer to Fig. 5.28

1. Draw the Front View and Top View as shown.
2. Draw the section plane A-A, parallel to X-Y line and 10 mm from point C.
3. Locate the POIs 1, 2 intersecting the circular base. (We can see again, as in case of Egs. 5.8 & Eg. 5.9, i.e. curved surfaces, we need to obtain more POIs)
4. So draw some concentric circles, Circle A (innermost) such that section plane is tangential to it, and another Circle B and project these circles as lines in Front View.
5. Locate points 3, 4 and 5 cutting the circles A & B and project all the POIs in the Top View.
6. Join all the points 1', 3', 4', 5' and 2' as a curve and section the area.

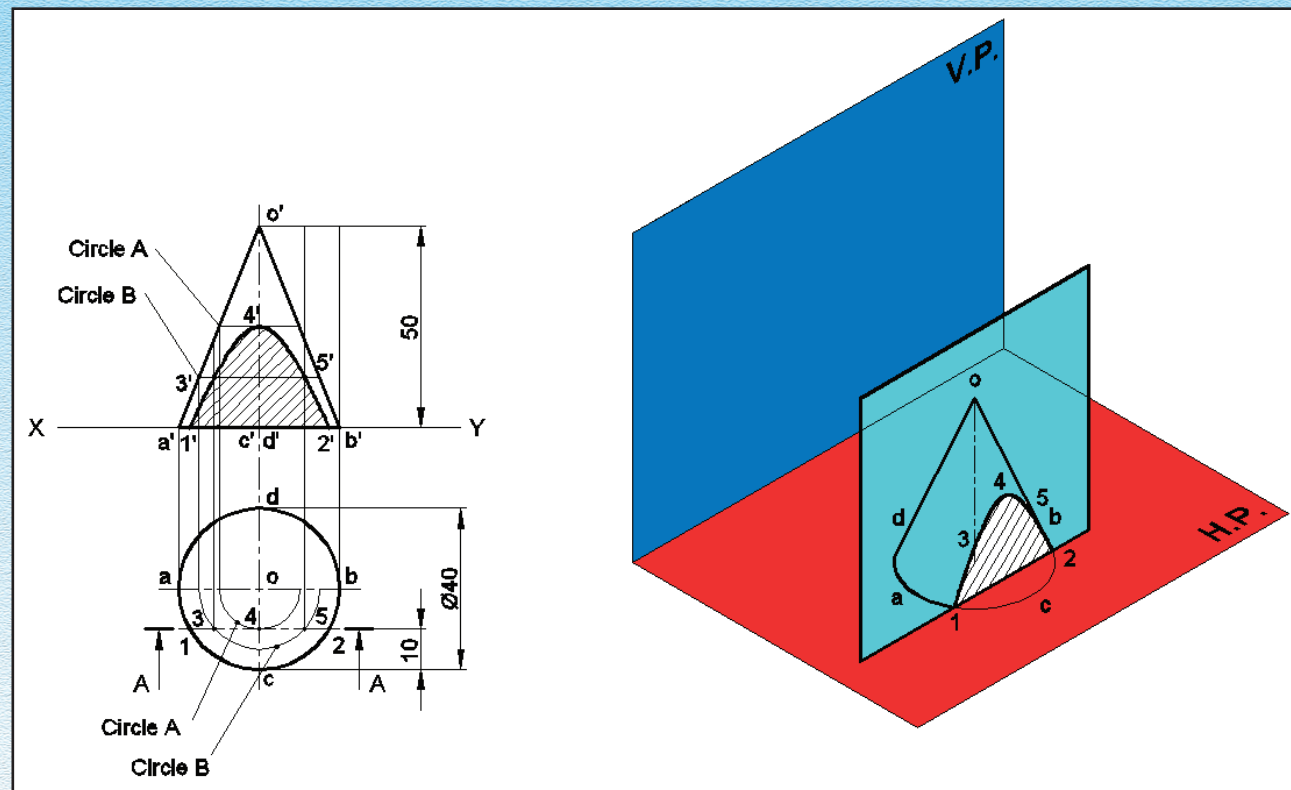


Fig. 5.28

5.3.2.4 : Section Plane Perpendicular to HP & Inclined to V.P.

Example 5.13 : A square prism of base side 40 mm and height 70 mm is resting on its rectangular face on the ground such that its axis is parallel to HP & VP. It is cut by a section plane perpendicular to HP & inclined to VP at an angle of 45° and passing through a point 10 mm from one of its ends. Draw the sectional Front View and Top View.

Solution : Refer to Fig. 5.29

1. Draw the Front View, Top View as helping side view as shown.
2. Draw line B-B inclined at 45° and 10 mm from end 'a'.
3. Locate POIs 1, 2, 3 and 4 intersecting the long edges.
4. Project these POIs in Front View and join the pts.
5. Hatch the area, and draw the remaining portion.

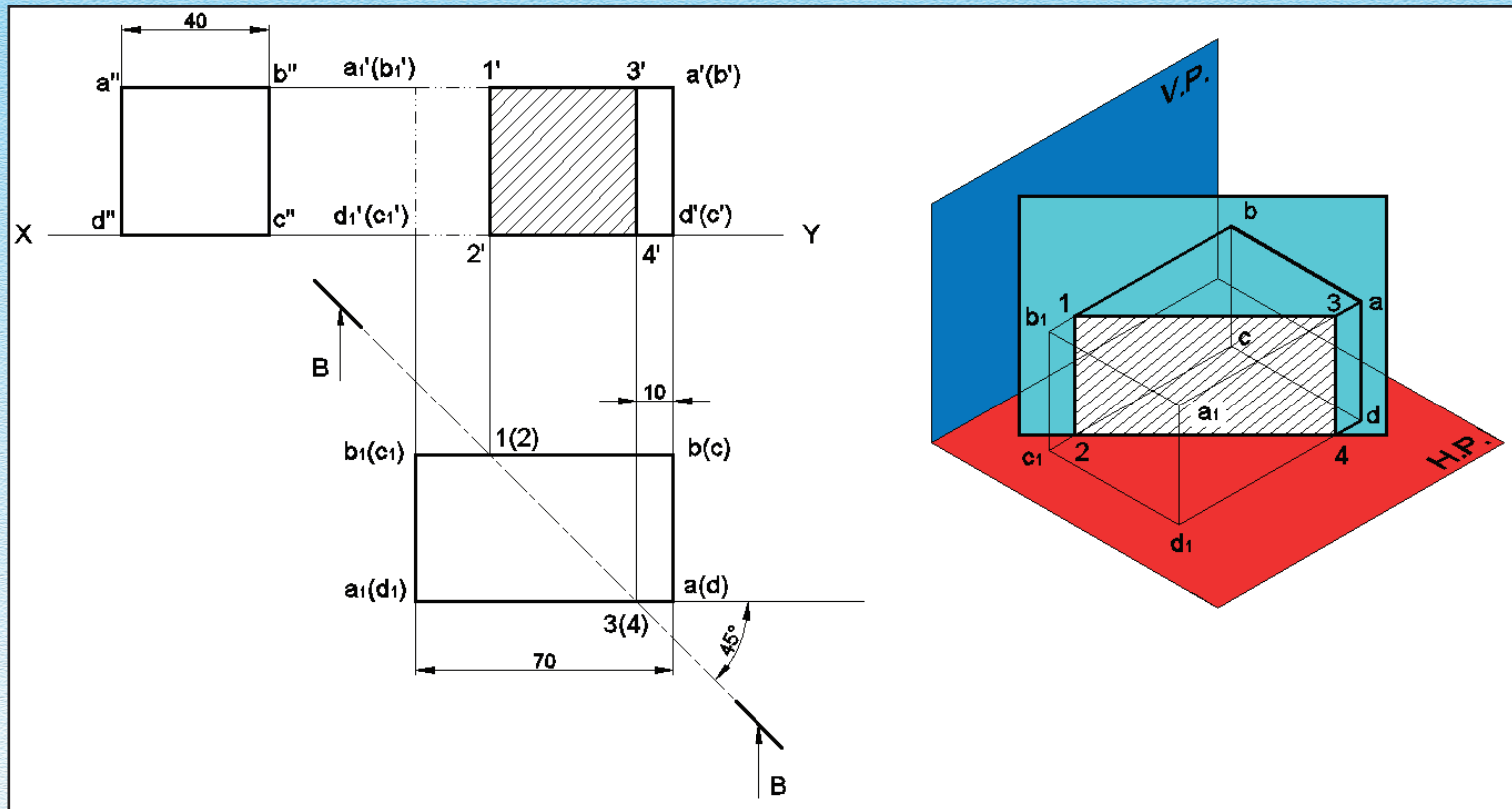


Fig. 5.29

Example 5.14 : A triangular pyramid is resting on its base on HP, such that one of its base edges at the rear is parallel to VP. Its base edge measures 35 mm and height 50 mm. A section plane inclined to VP at 45° and perpendicular to HP cuts the slant edge of the pyramid in front, at a distance of 5 mm from the axis. Draw the sectional Front View and Top View.

Solution : Refer to Fig. 5.30

1. Draw the Top View and Front View as shown.
2. In Top View, draw the section plane, inclined at 45° to VP at a distance of 5 mm from the axis pt. 'o(p)'
3. Locate POIs, 1, 2, 3 and 4 cutting the edges ac, oa, ob and bc respectively.
4. Project these pts. on the corresponding edges in the Front View. [But it can be seen that pt. 3 can't be projected vertically on the edge o'b' as similar to Example 5.7]
5. Similarly, we have an extra step, i.e. draw a line parallel to base from pt. 3 in Top View such that it meets one of the slant edges 'oa' at point 5. Then project pt. 5 in the Front View on the edge o'a' and then from pt 5', draw a line parallel to base meeting the edge o'b' at point 3'.
6. Join the pts 1'-2'-3'-4' and hatch the area.
7. Join the remaining portion. (Here also, some portion of the solid is removed & lies outside the section, so it is represented by dashed double dotted lines.)

Example 5.15 : A cone, base diameter 30 mm and axis 60 mm is resting on HP such that the axis is parallel to HP and perpendicular to VP. The apex is nearer to the observer. A section plane perpendicular to HP and inclined at 60° to VP bisects the axis. Draw its sectional Front View and Top View.

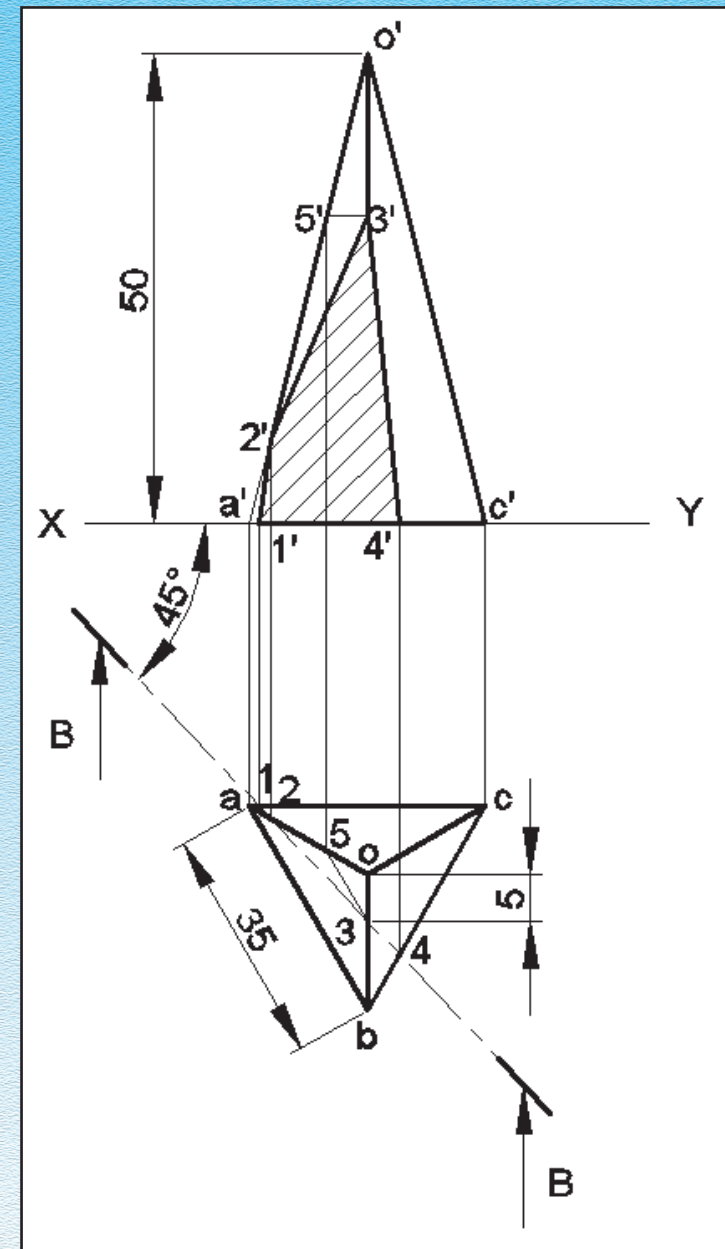


Fig. 5.30

Solution : Refer to Fig. 5.31

1. Draw the Front View and Top View as shown in the given position.
2. In Top View, draw the section plane B-B, passing through the mid point of the axis 0-01 and making an angle of 60° with VP as shown.
3. Locate the POIs 1, 2 & 3 cutting generator oa & base ac at two points. In this case, we can see they don't have edges as learnt in the previous chapter, so we divide the circle into equal parts (atleast 8 parts) and project these pts. in the other view as end points of generators.
4. We locate POIs 4, 5, 6 and 7 cutting generators "ob, oh, od" and "of" respectively.
5. Project all the POIs to pts 1', 2', 3', 4', 5', 6' and 7' on the corresponding generators in Front View.
6. Join 1'-4'-6'-2'-3'-7'-5' as a curve, since here also, the section plane is cutting a curved surface. Section the area.
7. Draw the remaining portion.

ADDITIONAL QUESTIONS

Example 5.16 : A pentagonal prism of base side 20 mm is resting on its 35 mm long rectangular edge on the ground such that the axis is parallel to HP and VP. A section plane inclined at 60° to HP and perpendicular to VP bisects the axis. Draw its projections and the sectional view.

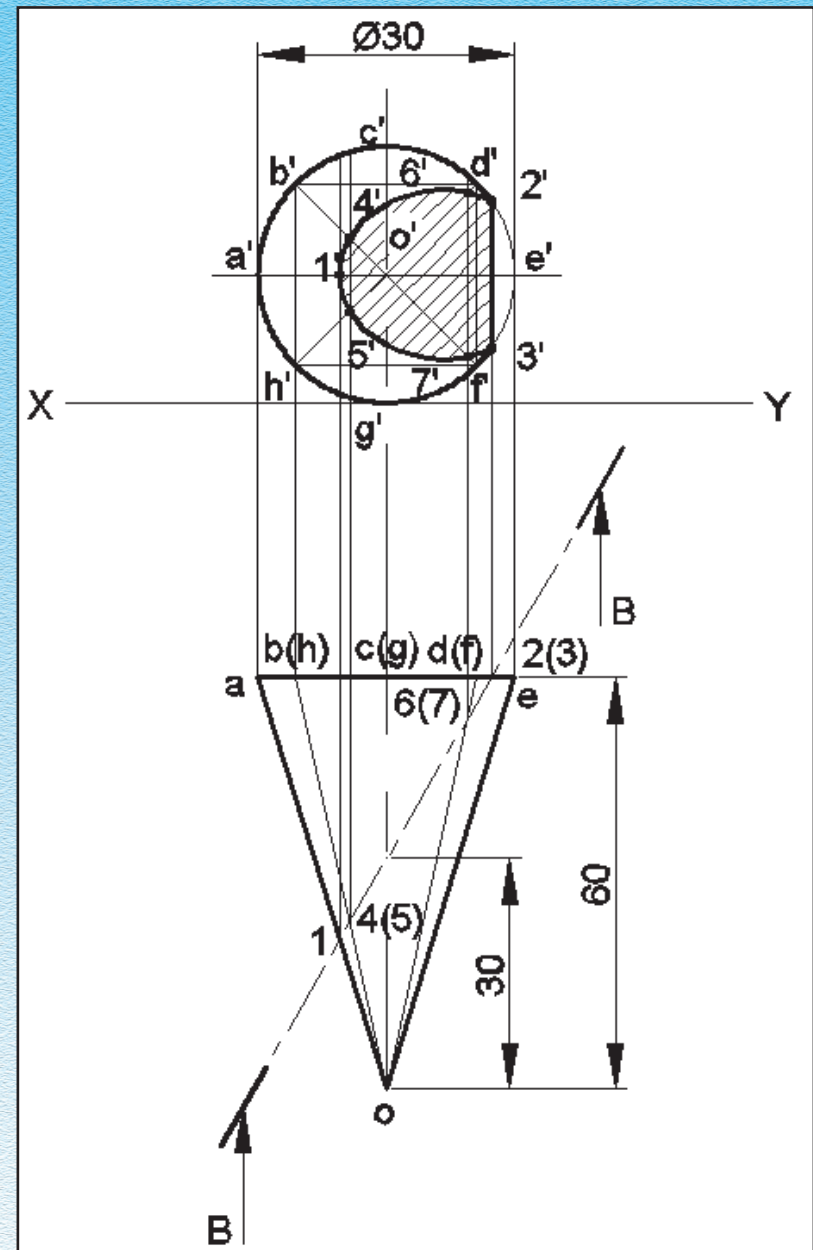


Fig. 5.31

Solution : Refer to Fig. 5.32

1. Draw the orthographic views Front View and Top View alongwith the helping view (side view)
2. In the Front View, draw the section plane B-B which bisects the axis and is inclined at 60° to HP.
3. Locate POIs 1', 2', 3', 4' & 5' in Front View at the intersections of the cutting plane with edges $a'-a_1'$, $b'-b_1'$, $e'-e_1'$, $c'-c_1'$, $d'-d_1'$, as shown.
4. Project these POIs in the Top View on the corresponding edges (can take help of the side view/end view to identify the edges).
5. Join pts. 1, 2, 3, 4 and 5 and section the area.
6. Draw the remaining portion of the object to get the sectional view.

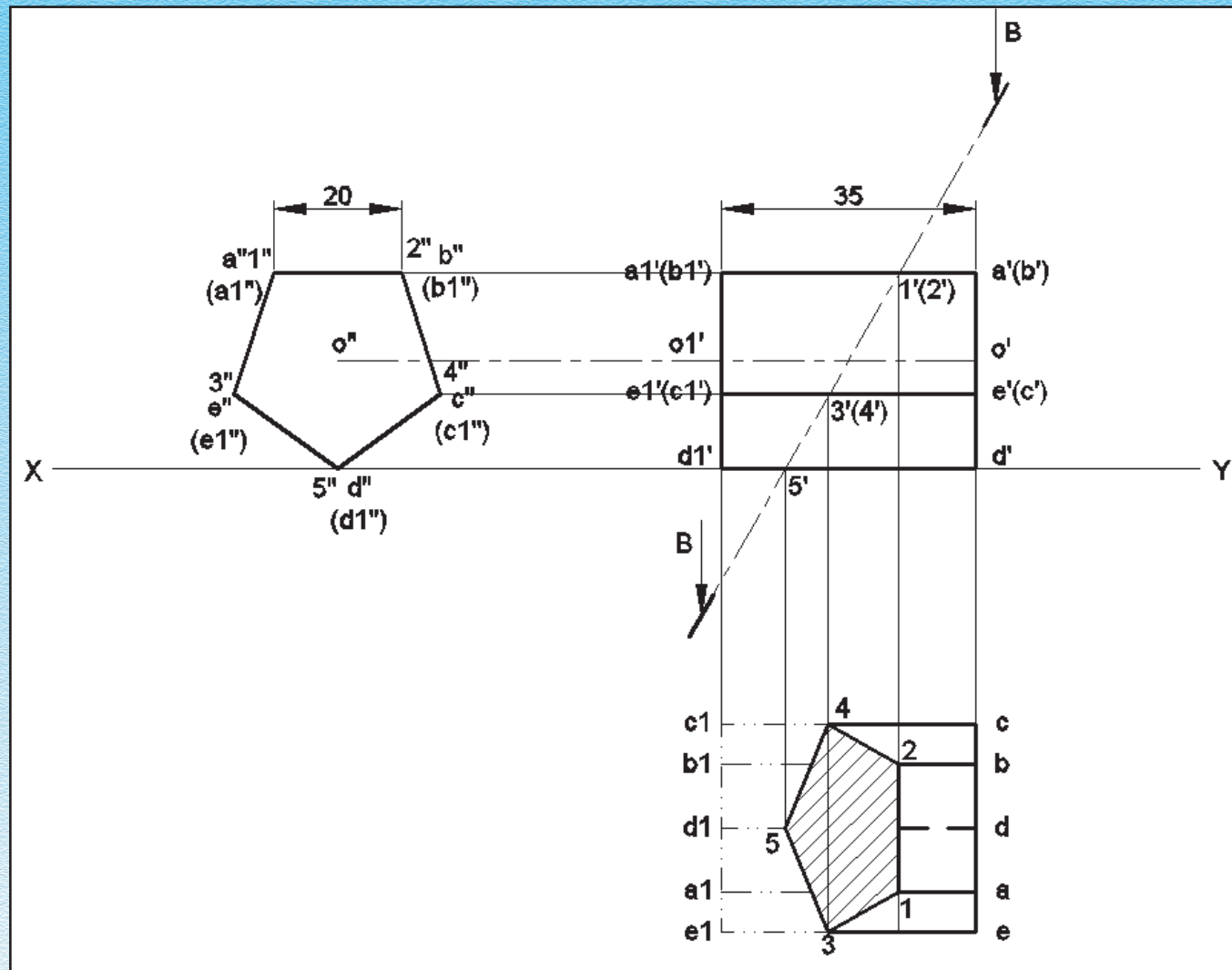


Fig. 5.32

Example 5.17 : A hexagonal pyramid of base edge 20 mm and height 40 mm is resting on one of its base edges on the ground, such that the axis is inclined at 30° to HP. A section plane parallel to HP and perpendicular to VP passing through the top-most corner of the base cuts the solid. Draw the Front View and sectional view.

Solution : Refer to Fig. 5.33

1. Draw the orthographic projections of the inclined solid as learnt in the previous chapter.
2. Draw the section plane A-A, meeting (corners) pts. b', a' and parallel to HP (X-Y line).
3. Locate the POIs 1', 2', 3', 4', 5', 6' meeting the edges o'b', o'a', o'c', o'f', o'd' & o'e' respectively.
4. Project these pts. in the other view (Top View) on the corresponding edges. Join 1, 2, 4, 6, 5 and 3 and draw section lines.
5. Draw the remaining portion of the solid in Top View.

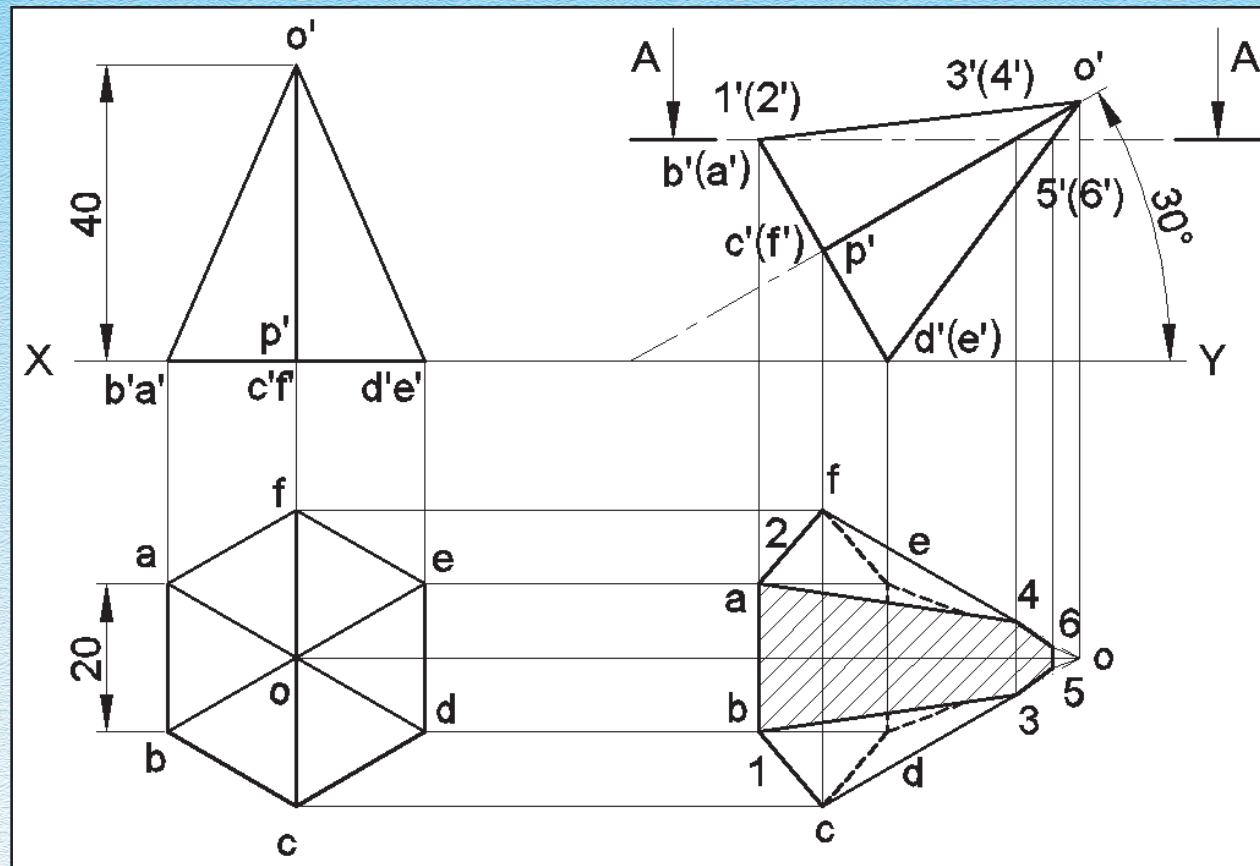


Fig. 5.33

To sum up, different section planes cut a square pyramid placed in various positions to obtain respective sectional views as shown in Fig. 5.34 (a), (b), (c) & (d).

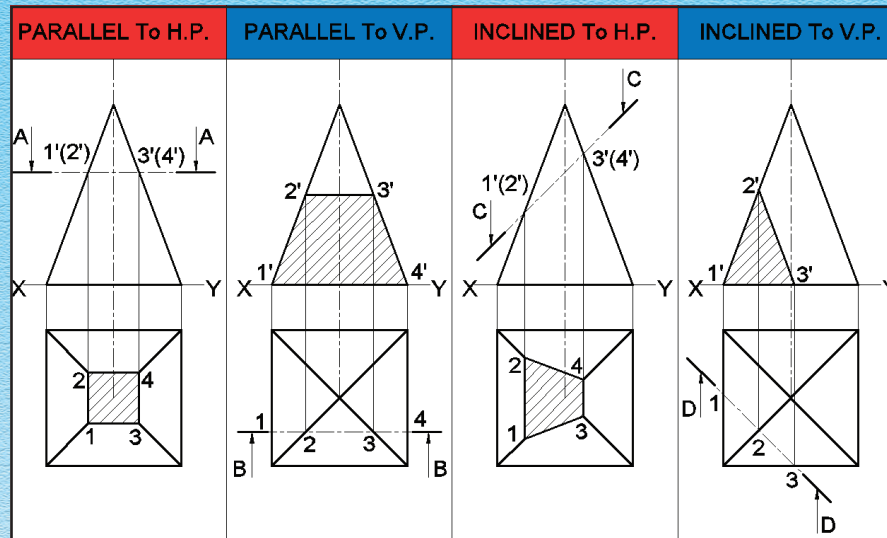


Fig. 5.34a

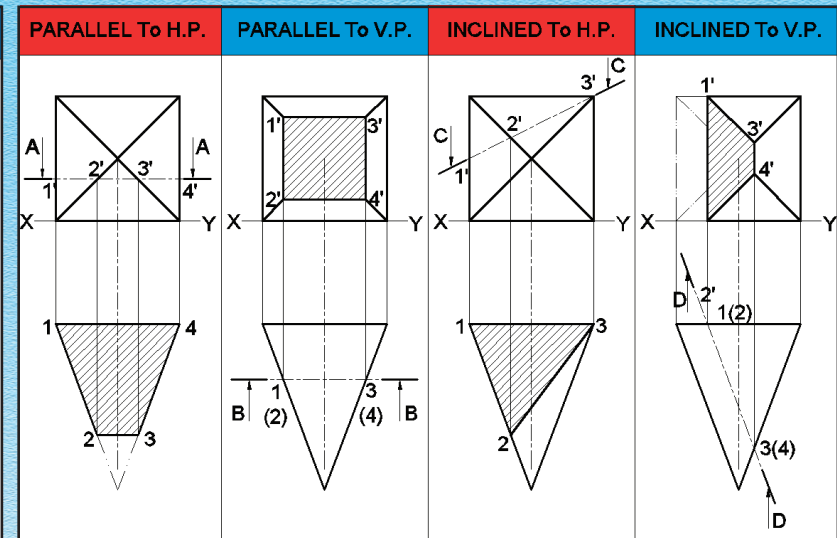


Fig. 5.34b

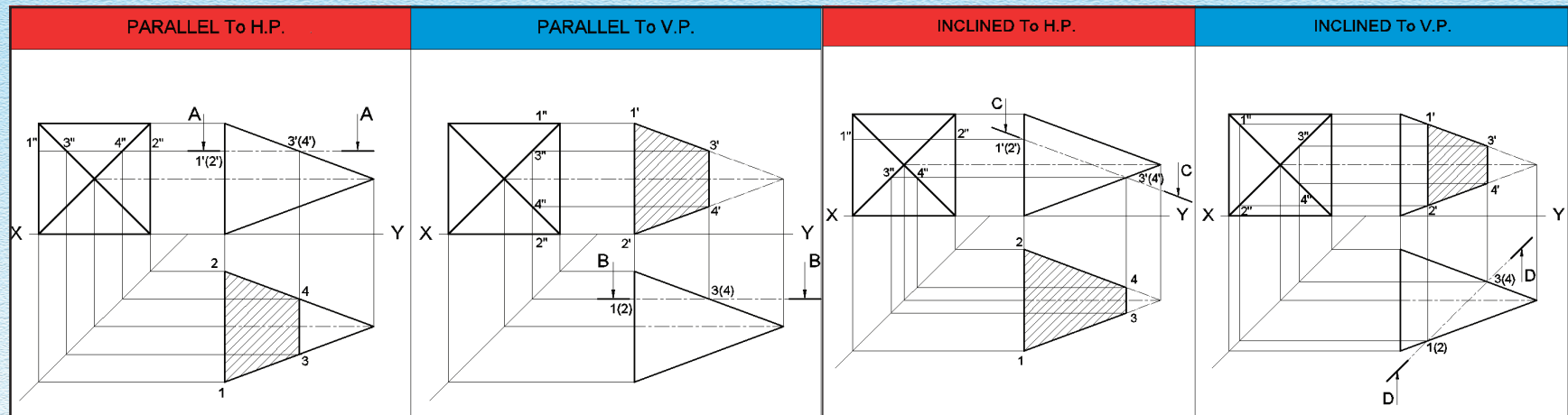


Fig. 5.34c

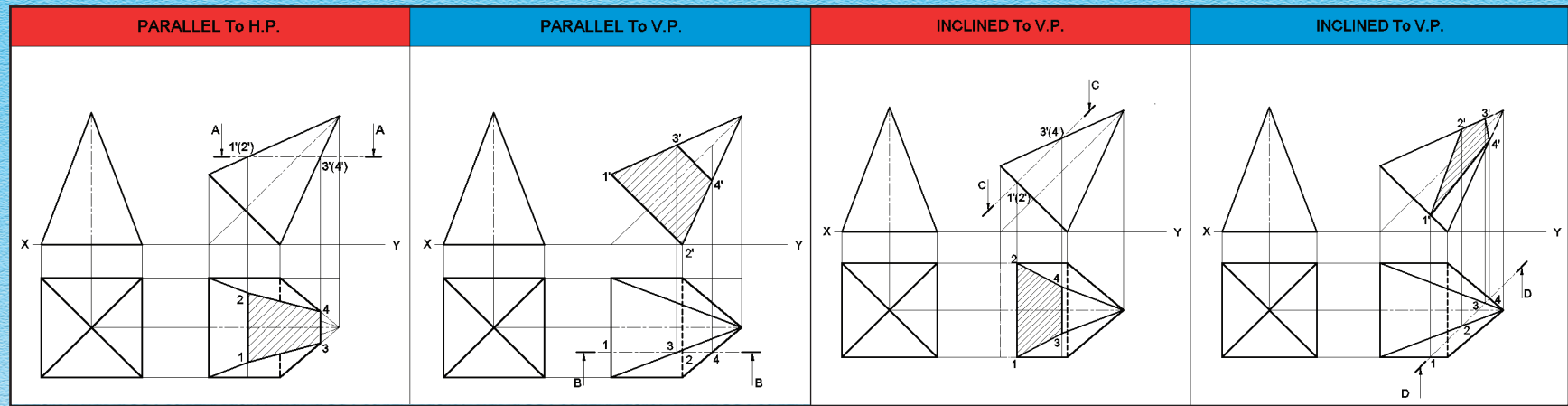


Fig. 5.34d

It can be seen in Fig. 5.34 (c) we may take help of the end (side) view (as in case of orthographic projection), to obtain the sectional/view.

Note : It is not necessary when Front View and Top View can be obtained directly.

In Figs. 5.34(a), (b) & (d) the basic concept to draw sectional views remain same but only the orthographic projections of the solid vary according to given conditions. Similarly in case of inclined solids (with axis inclined to VP/HP), the same procedure applies.

TRY THESE

1. In Fig. 5.35 (a) & (b), some solids are projected orthographically. Section planes A-A and B-B cut them respectively. Draw their respective sectional views.
2. A cylinder with 60 mm base diameter and 60 mm long axis, rests on its base on HP. It is cut by a section plane parallel to and 40 mm above HP. Draw its Front View and sectional Top View.
3. A pentagonal pyramid, side of base 30 mm and height 60 mm, rests on HP, with its axis vertical and an edge of base normal to VP. A horizontal cutting plane cuts the solid at height of 20 mm from the base. Draw front and sectional Top View of the pyramid.
4. A cube of 55 mm side has an edge on HP and axis inclined at 60° to HP. A vertical section plane parallel to VP and perpendicular to HP cuts the axis into two halves. Draw the projections and sectional view.

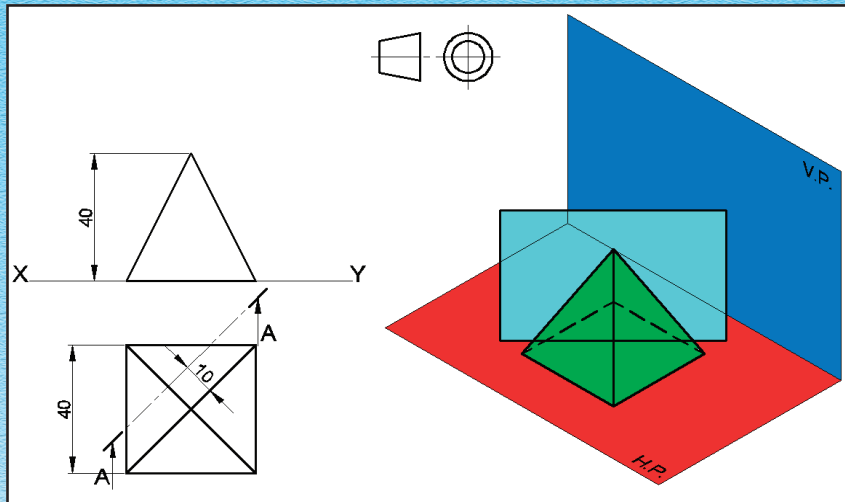


Fig. 5.35a

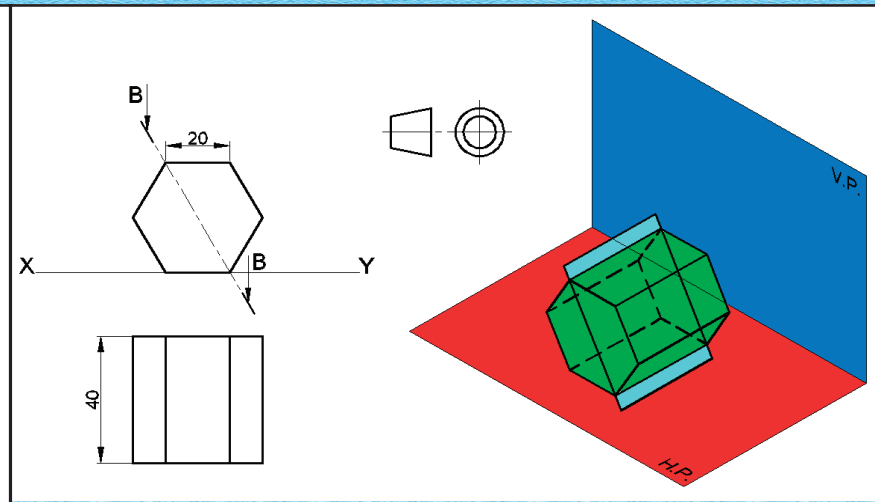


Fig. 5.35b

5.4 TRUE SHAPE OF A SECTION

Similar, to what we have learnt about true length in the previous chapter, here also we talk about true shape when we cut/section the object at some angle, i.e. the “section plane/cutting plane is inclined to HP or VP. Thus the sectional view of cut surface obtained is not the actual shape and is called as **“apparent section”**. To obtain the true shape of the section, we project it on another reference plane (auxiliary plane) parallel to the section plane as shown in the Fig. 5.36.

The true shape of the section can be obtained thus by viewing the object normal to the cut surface and projecting it on that “reference plane parallel to the section plane.”

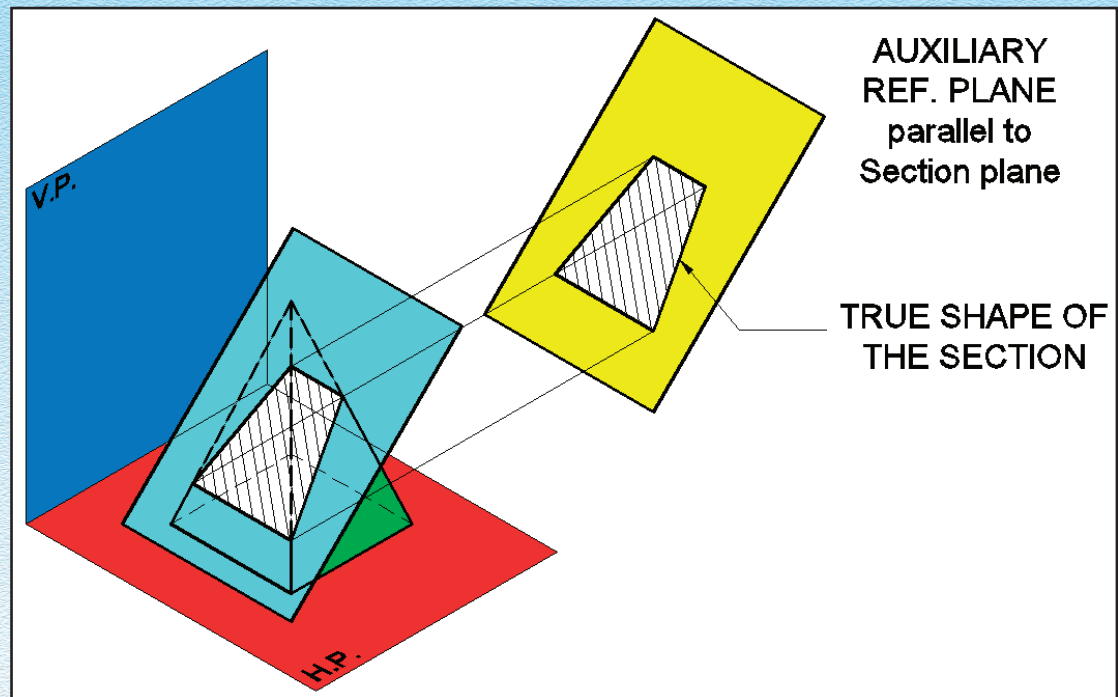


Fig. 5.36 Pictorial view of obtaining true shape of section

Note : If the section plane is parallel to HP/VP, then the True shape of the section will be visible in their respective sectional views itself.

ACTIVITY 5.3

1. Take a potato, bottle gourd or soap cakes and cut them at different angles, as shown in the Fig. 5.37

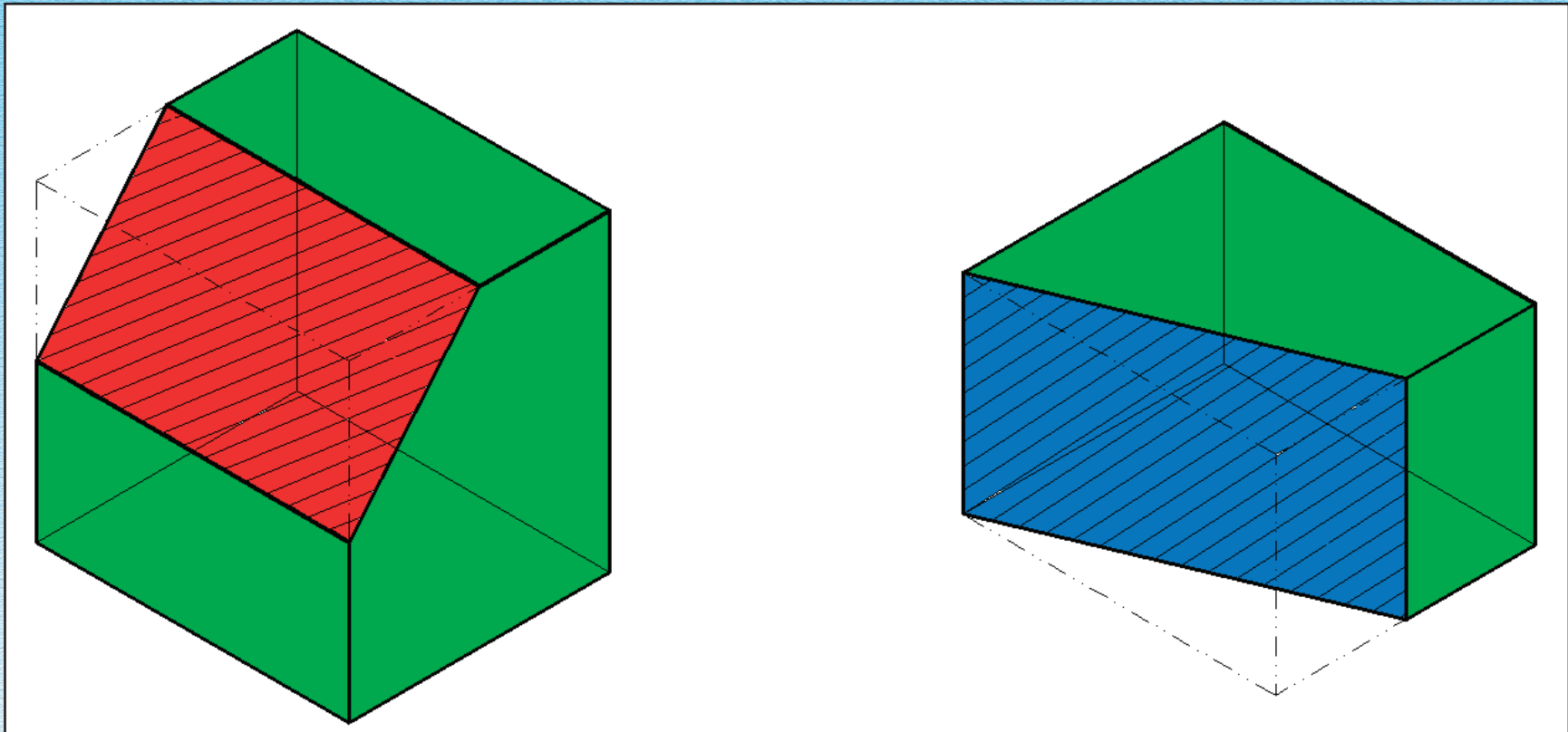


Fig. 5.37 Cut portions of different objects

2. Paint the cut surface visible/exposed to you.
3. Get some prints on a sheet of paper, by placing the painted surface firmly on the sheet. These prints will show the true shapes of the cut surfaces.

Similarly, you can get true shape prints of the cut surfaces of soap cake models of solids made in the Activity 5.2

5.4.1 Drawing Procedure for True Shape

Let us see how we can obtain (draw) the true shape of the section from the sectional view. Here also, we have to follow the procedure learnt earlier to draw the sectional view and then proceed further.

Let us consider the example of a vertical square pyramid which is cut by a section plane inclined to the ground (H.P.). It is pictorially shown in the Fig. 5.36

Steps of construction : Refer to Fig. 5.38

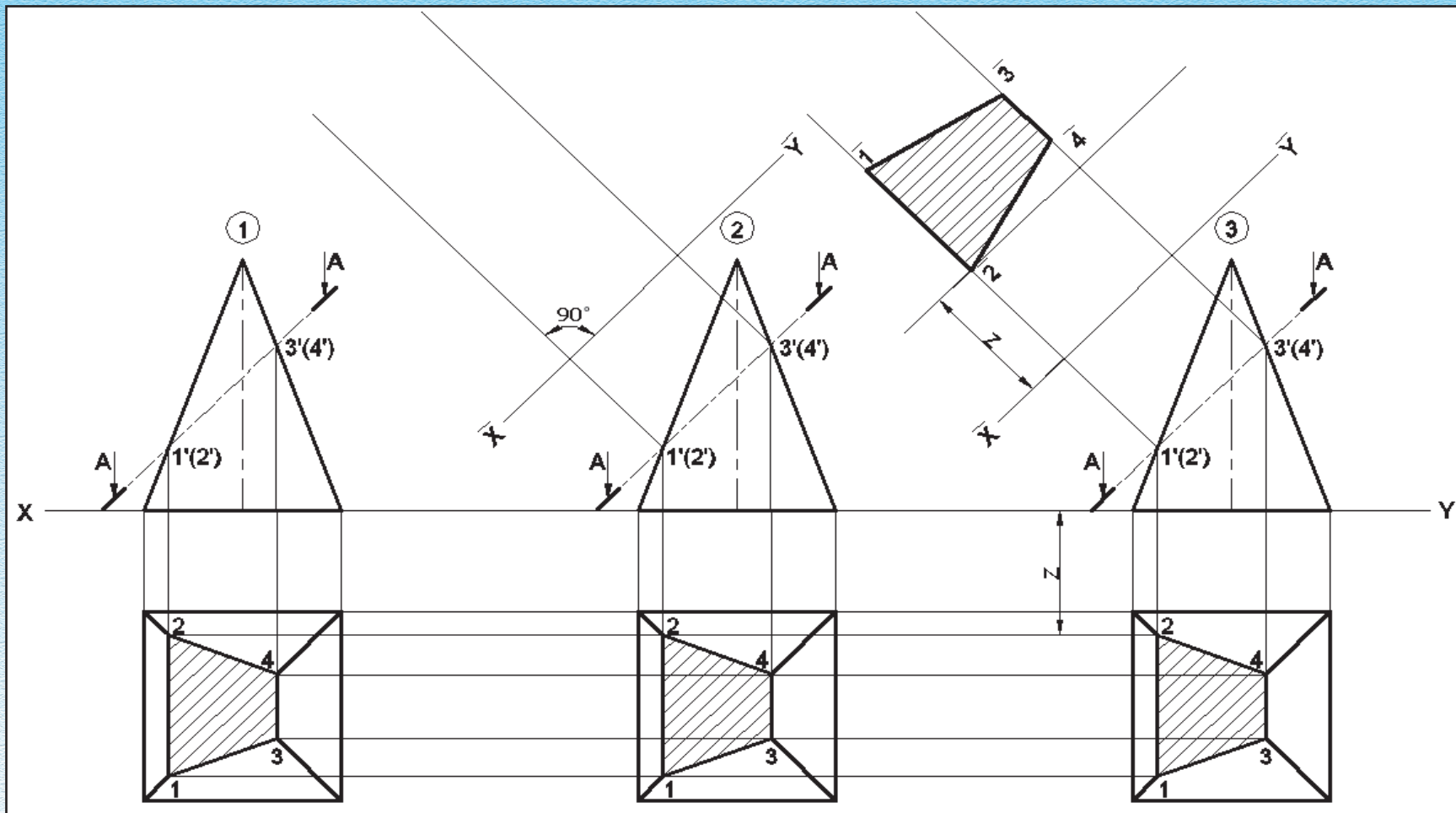


Fig. 5.38

1. Refer to Fig. 5.38 (1) Draw the projections of the solid including the sectional view as learnt earlier in (5.3)
2. Refer to Fig. 5.38(2) Draw a thin line $\bar{X}-\bar{Y}$, which represents the auxiliary plane, parallel to the section plane (here, A-A) at a convenient distance. Then draw projectors (thin lines perpendicular) to $\bar{X}-\bar{Y}$ from the POIs (here pts 1',2',3' & 4') intersecting the cutting plane.
3. Refer Fig. 5.38(3) Measure the distances of all these projected POIs in the sectional view with respect to X-Y line and mark them on their respective projectors from $\bar{X}-\bar{Y}$. Here distance 'z' of pt. 2 in the Top View is marked on the projector ($\perp$ line) with respect to $\bar{X}-\bar{Y}$. And so on for other POIs.
4. Join all the projected POIs wrt $\bar{X}-\bar{Y}$ with continuous thick lines. (Here, they are $\bar{1}, \bar{2}, \bar{3}$, & $\bar{4}$). Section the area. This is the true shape of the section.

[Fig. 5.38 Step-wise Procedure to obtain true shape of a section]

Let us consider some other examples to understand the drawing technique of true shape better.

5.4.2 Examples

Let us refer to the previous examples where the section plane is inclined and obtain the true shape of these sections.

Example 5.18 : A square prism of base side 50 mm and height of axis 80 mm has its base on HP. It is cut by a section plane perpendicular to VP and inclined to HP such that it passes through the two opposite corners of the rectangular face in front. Draw the sectional Top View and Front View and true shape of the section.

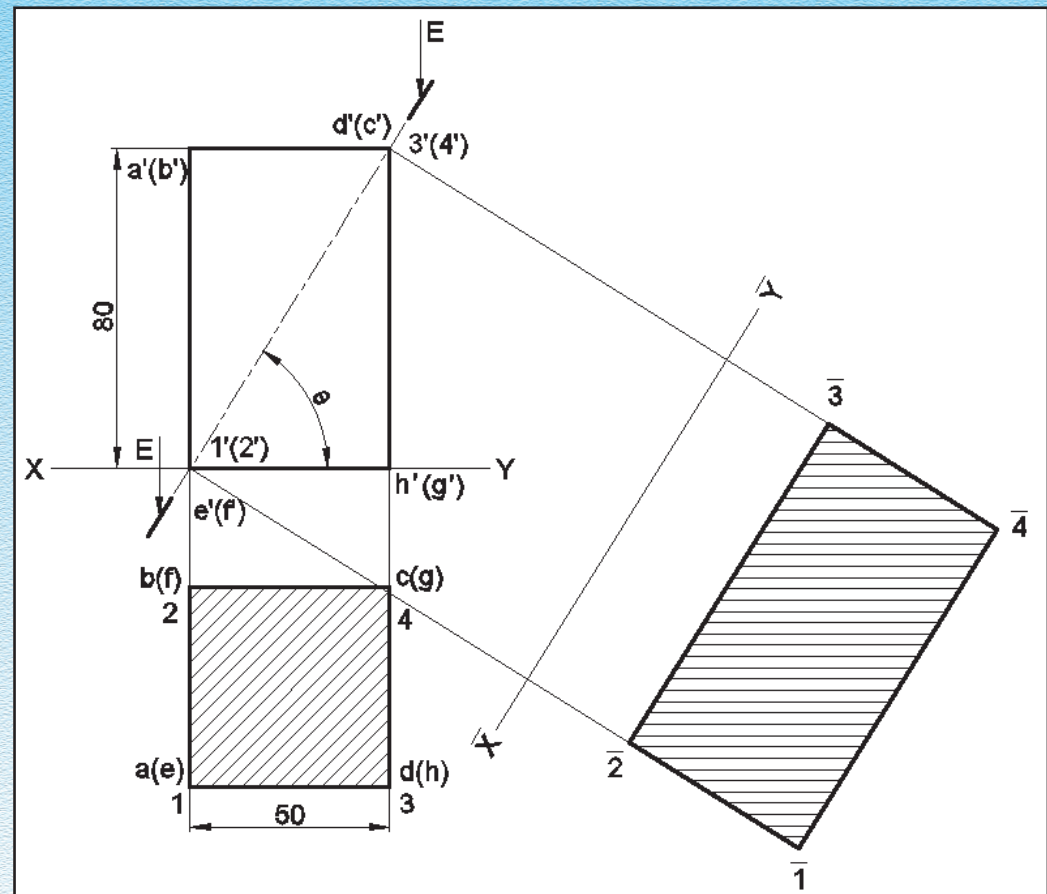


Fig. 5.39

Sol. : Refer to Fig. 5.39

1. Draw the Front View with the section plane and the sectional Top View, as learnt in example 5.4 previously.
2. Draw the reference (auxiliary) plane $\bar{X}-\bar{Y}$, parallel to the section plane E-E as shown in the Fig.
3. From the POIs in Front View i.e. $1'$, $2'$, & $3'$, $4'$, draw projectors perpendicular to the $\bar{X}-\bar{Y}$ line.
4. Measure the perpendicular distances of the pts 1, 2, 3, 4 in Top View wrt $X-Y$ and mark then on their corresponding projectors wrt $\bar{X}-\bar{Y}$.
5. Join the projected POIs $\bar{1}$, $\bar{2}$, $\bar{4}$ & $\bar{3}$ with continuous thick lines and hatch the area to obtain true shape of the section.

Example 5.19 : A cylinder of base diameter 50 mm and height 70 mm is resting on its curved surface on HP such that the axis is normal to VP. A section plane inclined to HP at an angle of 60° , passes through the axis and cuts the solid into two halves. Draw the Front View, sectional Top View and true shape of the section.

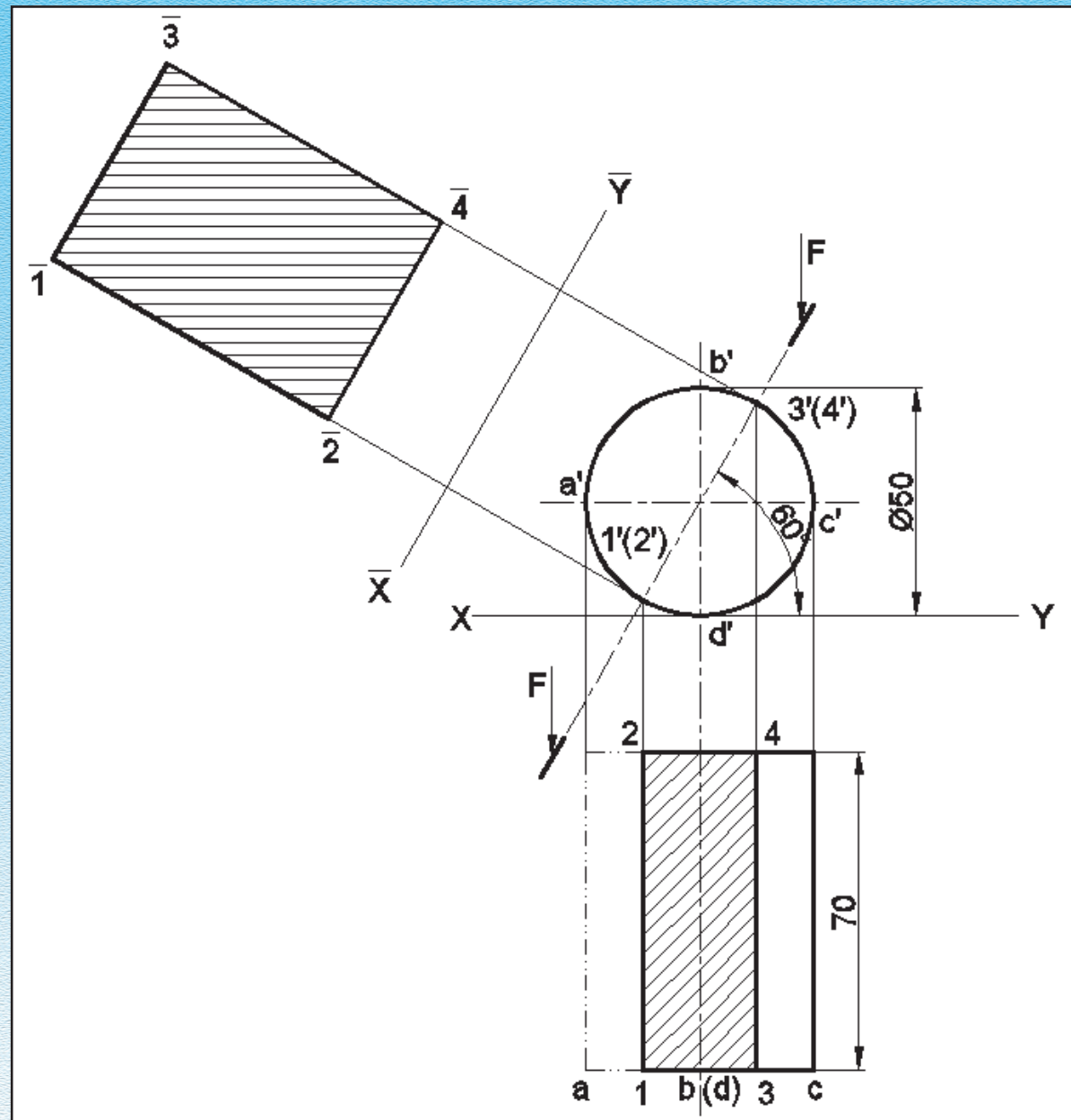


Fig. 5.40

Sol. : Refer to Fig. 5.40

1. Refer to example 5.5 and draw the orthographic projections with the sectional Top View as shown.
2. Draw the reference plane $\bar{X}-\bar{Y}$, parallel to the section plane F-F. From the POIs in the Front View, i.e. $1'2'$ & $3'4'$, draw projectors perpendicular to the $\bar{X}-\bar{Y}$ line.
3. Measure the perpendicular distances of these pts. 1, 2, 3 & 4 in the Top View wrt $X-Y$ and mark the same on their corresponding projectors wrt $\bar{X}-\bar{Y}$.
4. Join the projected POIs $\bar{1}, \bar{2}, \bar{4}$ & $\bar{3}$ and hatch the area. This is the true shape of the section.

Example 5.20 : A triangular pyramid is resting on one of its base corners on the ground, such that its 30 mm base side on top is parallel to HP. Its 65 mm long axis is $\perp$ to V.P. It is cut by a section plane perpendicular to V.P. and inclined to HP at 60° such that it bisects the top base edge. Draw its Front View and sectional Top View and obtain true shape of the section.

Sol. : Refer to Fig. 5.41

1. Draw the Front View and sectional Top View, as suggested in the Example 5.6.

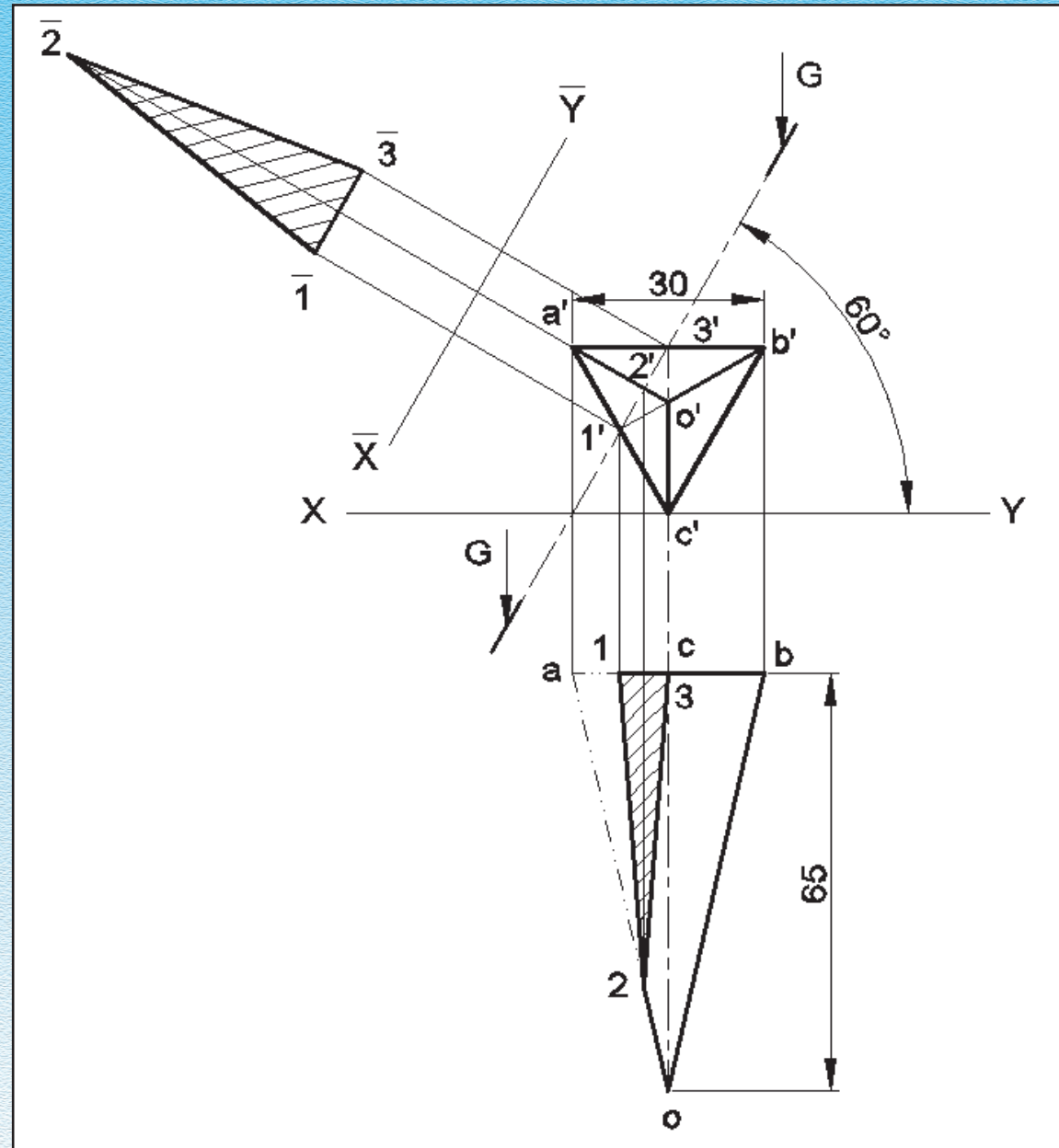


Fig. 5.41

2. Draw the auxiliary plane $\bar{x}-\bar{y}$, parallel to section plane and from the POIs 1', 2', & 3' in the Front View, draw projectors perpendicular to the $\bar{x}-\bar{y}$ line.
3. Measure the perpendicular distances of pts 1, 2, 3 in the Top View wrt X-Y and mark the same on their corresponding projectors wrt $\bar{x}-\bar{y}$.
4. Join the projected POIs, $\bar{1}, \bar{2}$ & $\bar{3}$ and draw section lines, to obtain the true shape of the section.

Example 5.21 : A vertical pentagonal pyramid is lying on its base on HP with one of its 45 mm long base edge at the rear parallel to V.P. It is cut by a section plane inclined at 60° to HP and bisects the axis. The axis measures 80 mm. Draw the Front View and sectional Top View and draw the true shape of the section.

Sol. : Refer to Fig. 5.42

1. Draw the Front View and sectional Top View as shown. (Refer to example 5.7)

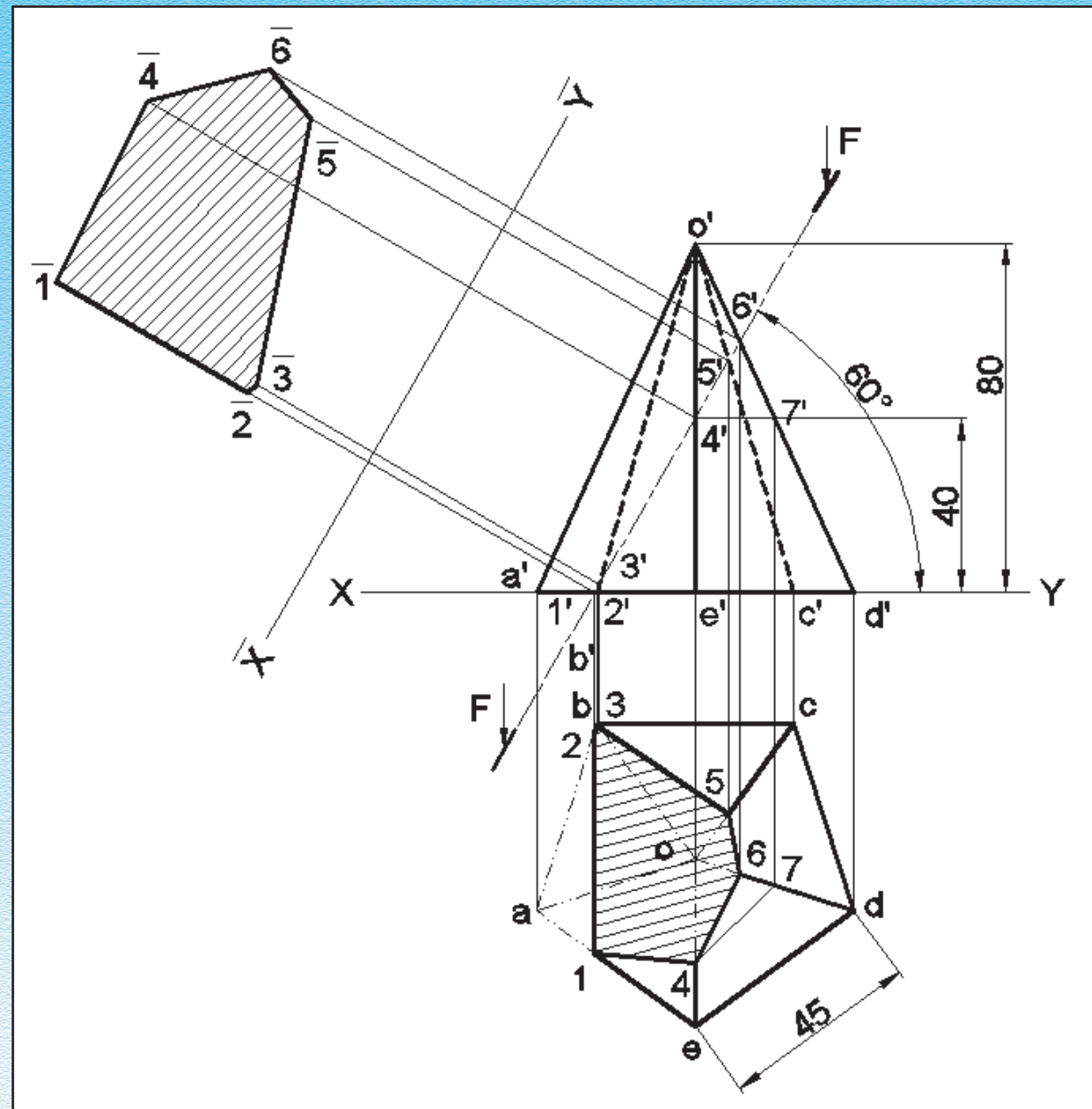


Fig. 5.42

2. Draw reference plane, $\bar{X}-\bar{Y}$ line parallel to section plane F-F and draw perpendicular lines (projectors) from the POs 1', 2', 3', 4', 5' & 6' in the Front View
3. Measure the perpendicular distance of their respective POs 1, 2, 3, 4, 5 & 6 in the Top View and mark the same on the corresponding projectors wrt $\bar{X}-\bar{Y}$ line.
4. Join the pts. $\bar{1}, \bar{2}, \bar{3}, \bar{5}, \bar{6}$ & $\bar{4}$ and hatch the area to obtain true shape of the section.

Example 5.22 : A cone of ϕ 60 mm base and axis of length = 80 mm is resting on its circular face on H.P. It is cut by a section plane inclined at 60° to HP and meets the axis at a point 30 mm below its apex. Draw the sectional Front View and Top View. Draw the true shape of the section.

Sol. : Refer to Fig. 5.43

1. Draw the Front View and sectional Top View as shown in the figure (Refer to example 5.8)
2. Draw the reference plane

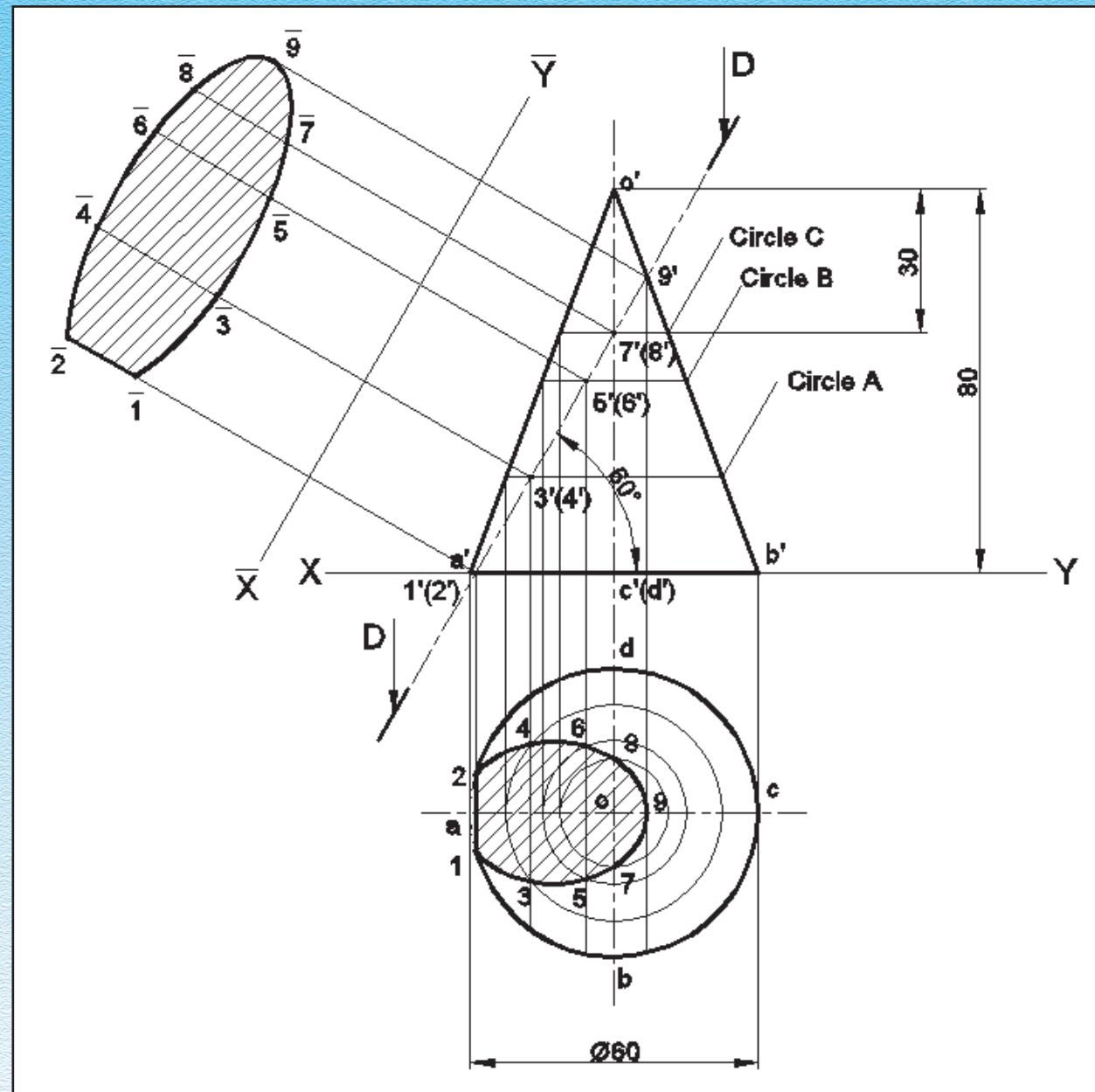


Fig. 5.43

$\bar{x}-\bar{y}$, parallel to the section plane D - D From the POs in the Front View, i.e. 1' & 3'4', 5'6', 7'8' & 2' draw projectors perpendicular to the $\bar{x}-\bar{y}$ line.

3. Measure the perpendicular distances of pts. 1, 3, 4, 5, 6, 7, 8 & 2 in the Top View from X - Y line and mark the same on their corresponding projectors wrt $\overline{X}-\overline{Y}$.
4. Join the projected POIs $\overline{1}, \overline{3}, \overline{5}$ & $\overline{8}, \overline{2}, \overline{7}, \overline{6}$ & $\overline{4}$ as a curve and hatch the area. This is the true shape of the section. (As it is curved surface, so the pts are joined as a curve, both in section as well as true shape)

Example 5.23 : A sphere of 32 mm diameter is cut by a horizontal section plane inclined at 45° to the HP and at a distance of 8 mm from O the centre. Draw the Front View & sectional Top View, and true shape of the section.

Sol. : Refer to Fig. 5.44

1. Draw the Front View and sectional Top View as shown (Refer to Example 5.9)
2. Draw $\bar{X}-\bar{Y}$ parallel to the section plane A-A at a suitable distance, and project perpendicular lines from the POIs in the Front View ($1', 3' \& 4', 5' \& 6', 7' \& 8', 9' \& 10', 11' \& 12'$ and $2'$) to the $\bar{X}-\bar{Y}$ reference line.
3. Mark their respective distances from X - Y line wrt Top View, on their corresponding projectors wrt $\bar{X}-\bar{Y}$.

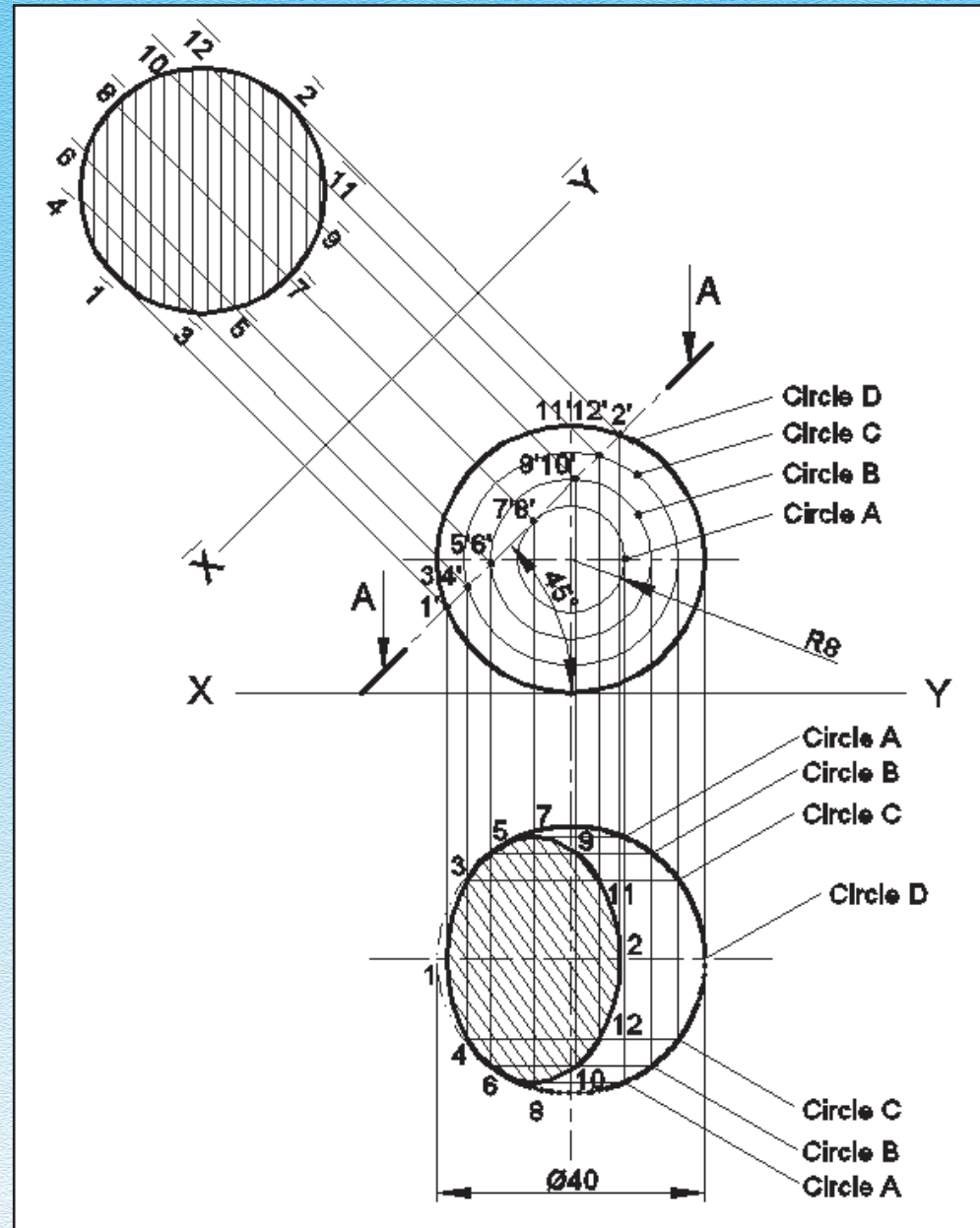


Fig. 5.44

4. Join points $\bar{1}, \bar{4}, \bar{6}, \bar{8}, \bar{10}, \bar{12}, \bar{2}, \bar{11}, \bar{9}$ as a curve, and hatch the area.

It can be seen that the true shape is a circle

[**Note :** True shape of any inclined section plane cutting a sphere is always a 'circle']

Example 5.24 : A square prism of base side 40 mm and height 70 mm is resting on its rectangular face on the ground such that its axis is parallel to HP & VP. It is cut by a section plane perpendicular to HP & inclined to VP at an angle of 45° and passing through a point 10 mm from one of its ends. Draw the sectional Front View and Top View. Also draw true shape of the section.

Sol. : Refer to Fig. 5.45

1. Draw the Top View and sectional Front View as shown (Refer to Example 5.13)
2. Draw Reference plane

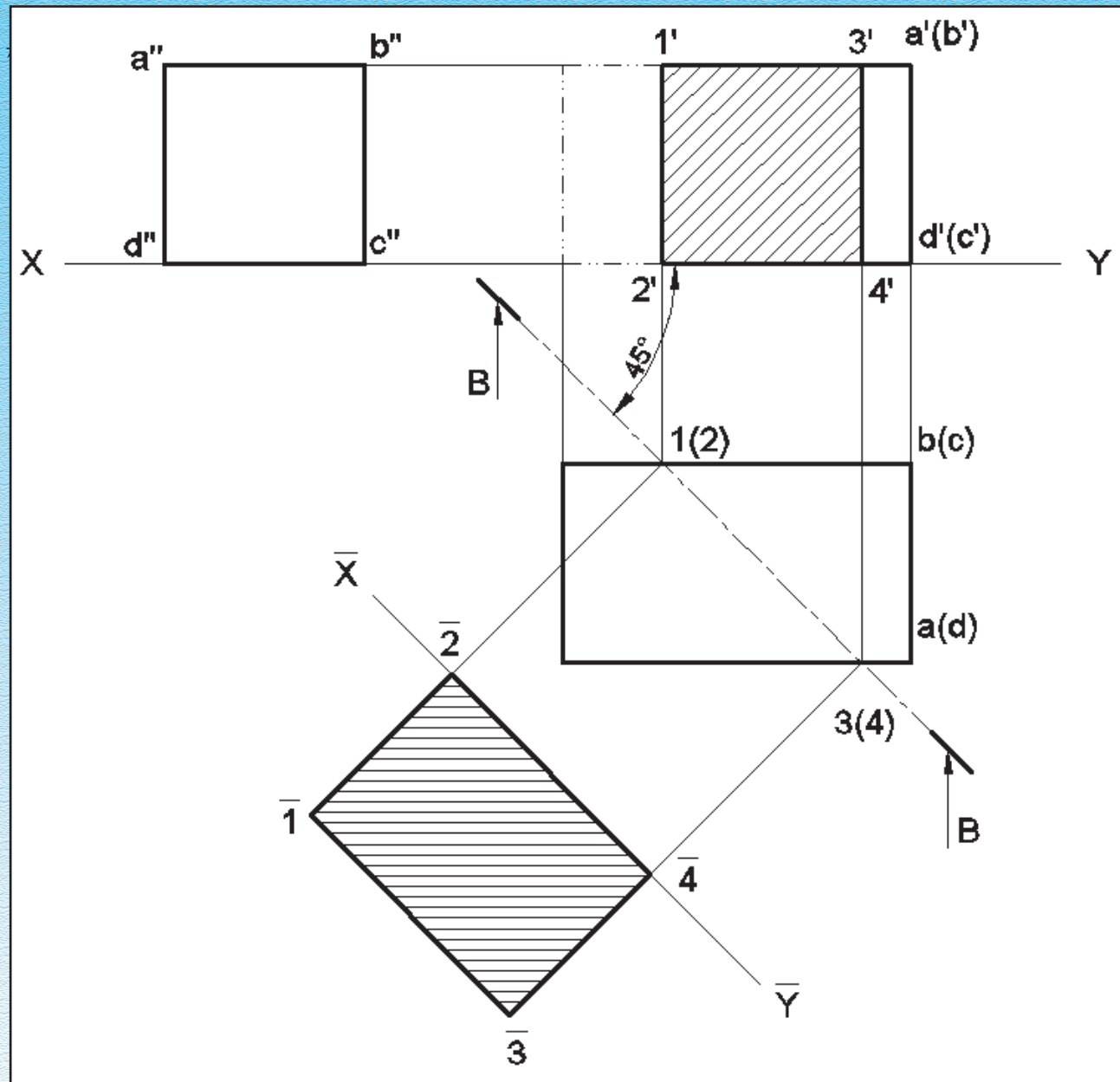


Fig. 5.45

$\bar{x}-\bar{y}$ at a suitable distance parallel to the section plane B-B. Draw perpendicular projectors to the $\bar{x}-\bar{y}$ line from the POIs (1, 2 & 3, 4) in the Top View.

- Measure perpendicular distance of projected POIs in Front View (pts 1', 2', 4' & 3') wrt X - Y line and mark them on their corresponding projectors wrt $\bar{x}-\bar{y}$.
- Join the pts. $\bar{1}, \bar{2}, \bar{4}$ & $\bar{3}$ and hatch the area. This is the true shape of the section.

Example 5.25 : A triangular pyramid is resting on its base on HP, such that one of its base edges at the rear is parallel to VP. Its base edge measures 25 mm and height 50 mm. A section plane inclined to VP at 45° and perpendicular to HP cuts the slant edge of the pyramid in front, at a distance of 5 mm from the axis. Draw the sectional Front View and Top View. Obtain the true shape of the section.

Sol. : Refer to Fig. 5.46

- Draw the Top View and sectional Front View as shown.
- Draw the $\bar{x}-\bar{y}$ line parallel to section plane B-B, and draw projectors (perpendicular lines) to it from the POIs (1, 2, 3 & 4)
- Measure the distances of the projected POIs in Front View (1', 2', 3' & 4') from X - Y and mark these distances on the corresponding projectors wrt $\bar{x}-\bar{y}$ line.
- Join the pts. ($\bar{1}, \bar{4}, \bar{3}$ & $\bar{2}$) and section the area. This is the true shape of the section.

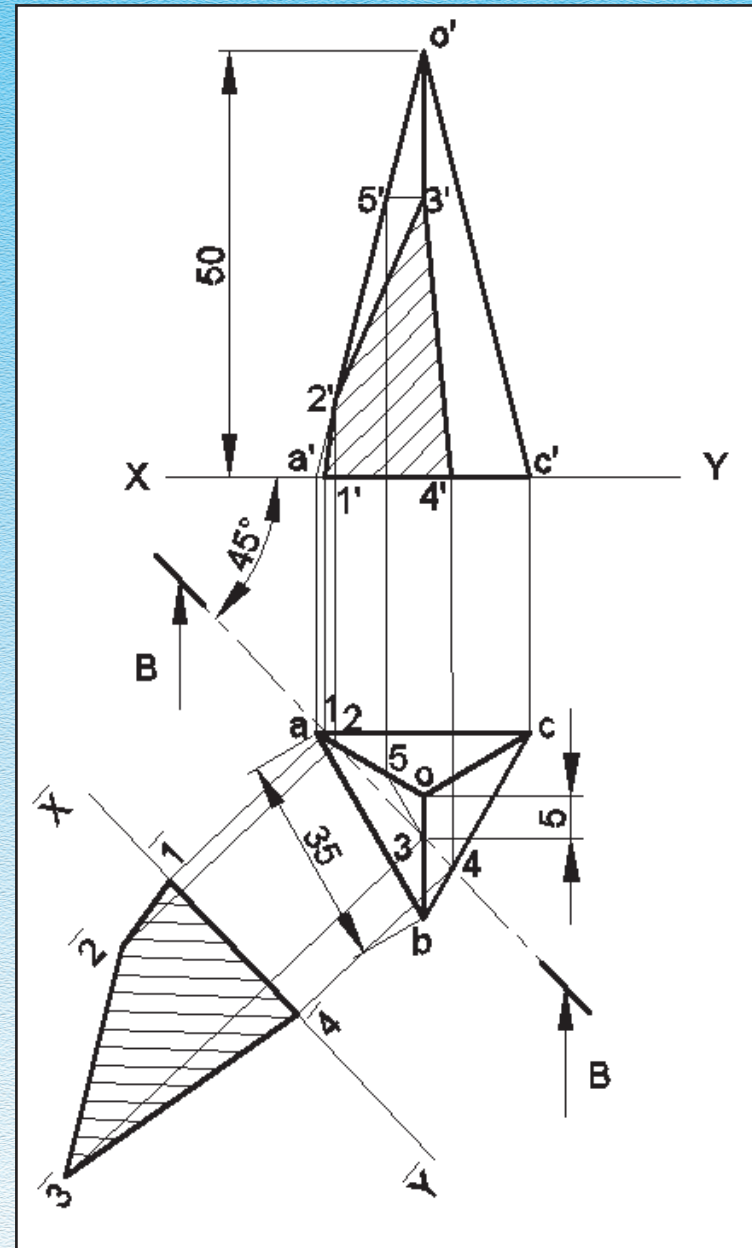


Fig. 5.46

Example 5.26 : A cone, base diameter 30 mm and axis 60 mm is resting on HP such that the axis is parallel to HP and perpendicular to VP. The apex is nearer to the observer. A section plane perpendicular to HP and inclined at 60° to VP bisects the axis. Draw its sectional Front View and Top View. Draw the true shape of the section.

Sol. : Refer Fig. 5.47

1. Draw the sectional Front View and Top View as shown (Refer to example 5.15).
2. Draw line $\bar{X}-\bar{Y}$ and draw projectors to it from POIs in the Top View (pts. 1, 4 & 5, 6 & 7, 2 & 3).
3. Measure their distances wrt $X-Y$ line from their projected pts in the Front View ($1', 4', 5', 6', 7', 2' & 3'$) and mark these distances on the corresponding projectors wrt $\bar{X}-\bar{Y}$.
4. Join the marked pts. $\bar{1}, \bar{5}, \bar{7}, \bar{3}, \bar{2}, \bar{6} & \bar{4}$ as a curve and section the area.

This is the desired true shape of the section.

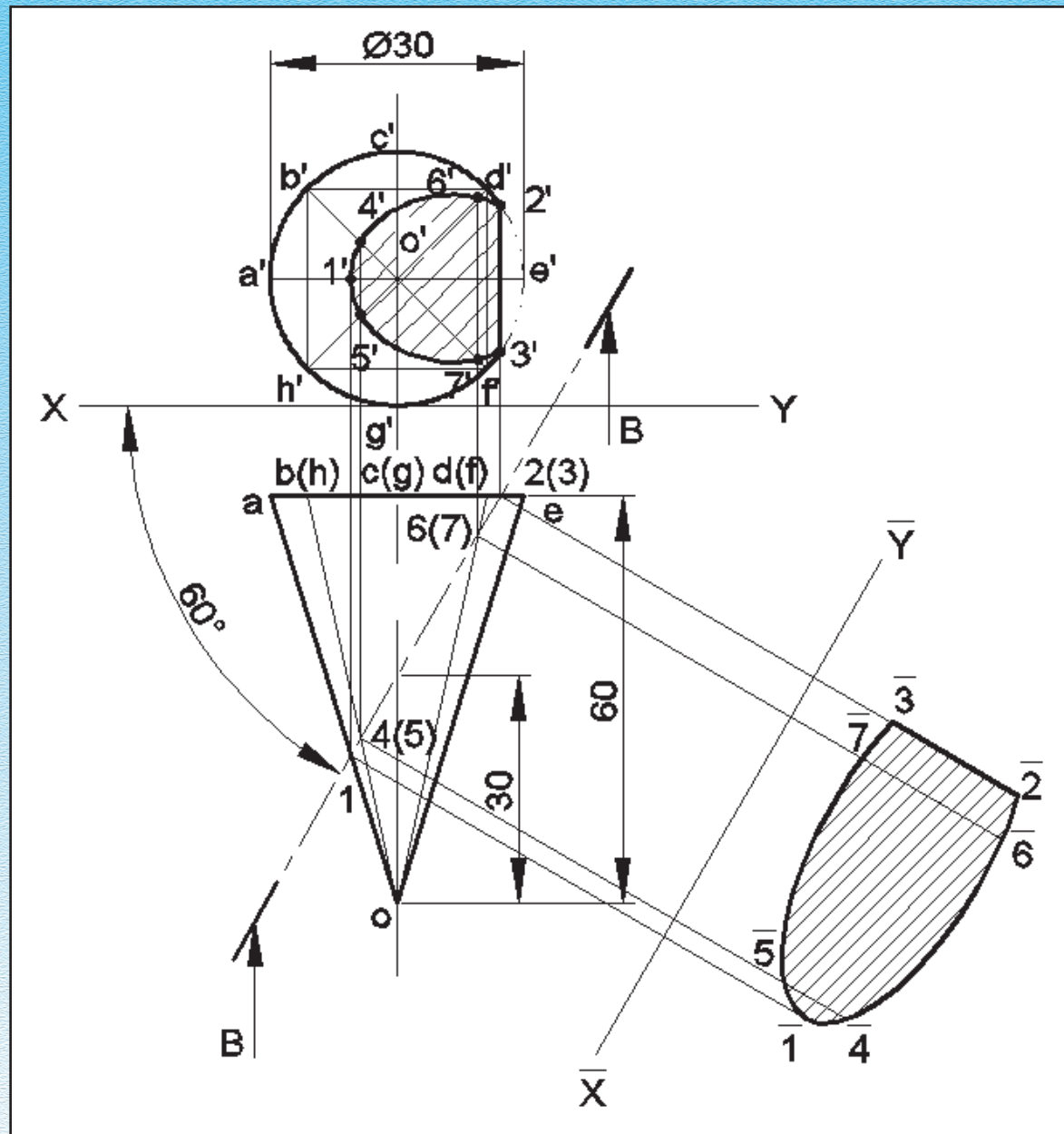


Fig. 5.47

Example 5.27 : A vertical cylinder of 30 mm dia and 40 mm height rests on its base on the ground. A section plane inclined at 45° to HP and perpendicular to VP cuts the axis, 10 mm away from the top face. Draw the projections & the sectional view. Draw the true shape of the section.

Solution : Refer to Fig. 5.48

1. Draw the Front View with the section plane and the sectional Top View of the vertical cylinder as shown.
2. Draw the reference plane $\bar{X}-\bar{Y}$ parallel to section plane A-A. From the POIs in Front View, i.e. 1', 2', 3', 4', 5' & 6', 7', draw projectors perpendicular to the $\bar{X}-\bar{Y}$ line.
3. Measure the perpendicular distances of pts 1, 2, 3, 4, 5, 6, & 7 in the Top View wrt X-Y and mark the same on the corresponding projectors wrt $\bar{X}-\bar{Y}$.

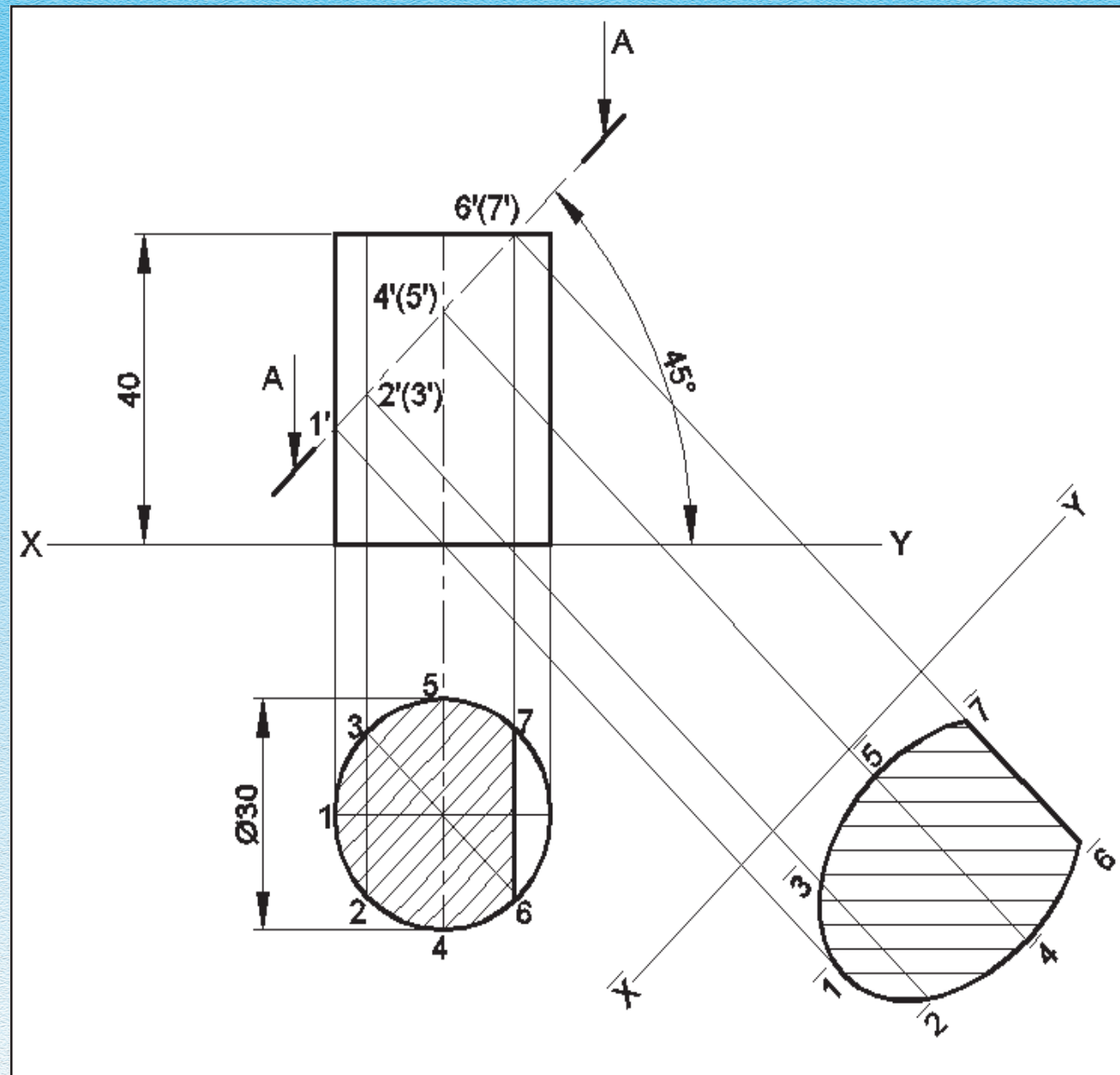


Fig. 5.48

- Join the projected POIs $\bar{1}, \bar{3}, \bar{5}, \bar{7}, \bar{6}, \bar{4}, \bar{2}$ with continuous thick lines and hatch the area to obtain the true shape of the section. (As it is a curved surface, hence the section as well as the true shape is joined as a curve except $\bar{6} - \bar{7}$ which is a straight edge)

Example 5.28 : A pentagonal pyramid is resting on one of its 20 mm long base edge on HP. Its 45 mm long axis is perpendicular to VP. A section plane inclined at 30° to VP cuts the axis, 20 mm away from the base. The apex is in front. Draw the Top View, the sectional Front View and its true -shape.

Solution : Refer to Fig. 5.49

- Draw the projections and the sectional view as shown in the figure. (It can be noticed, pt. 3 could not be projected directly, so a line parallel to base meeting the slant edge at pt. 6 was constructed. Then from the projected pt. 6', a line parallel to base was drawn to obtain pt. 3' in the Front View.
- Draw the line $\bar{X}-\bar{Y}$ parallel to the section plane B-B and draw projectors to $\bar{X}-\bar{Y}$ from pts. 1, 2, 3, 4 & 5 in the Top View.
- Measure distances of the projected POIs $\bar{1}-\bar{2}-\bar{3}-\bar{4}-\bar{5}$ wrt $X-Y$ and mark them on their corresponding projectors, taking the same respective distances wrt $\bar{X}-\bar{Y}$.
- Join pts. $\bar{1}-\bar{2}-\bar{4}-\bar{5}-\bar{3}$, and draw section lines. This is the true shape of the sectioned surface.

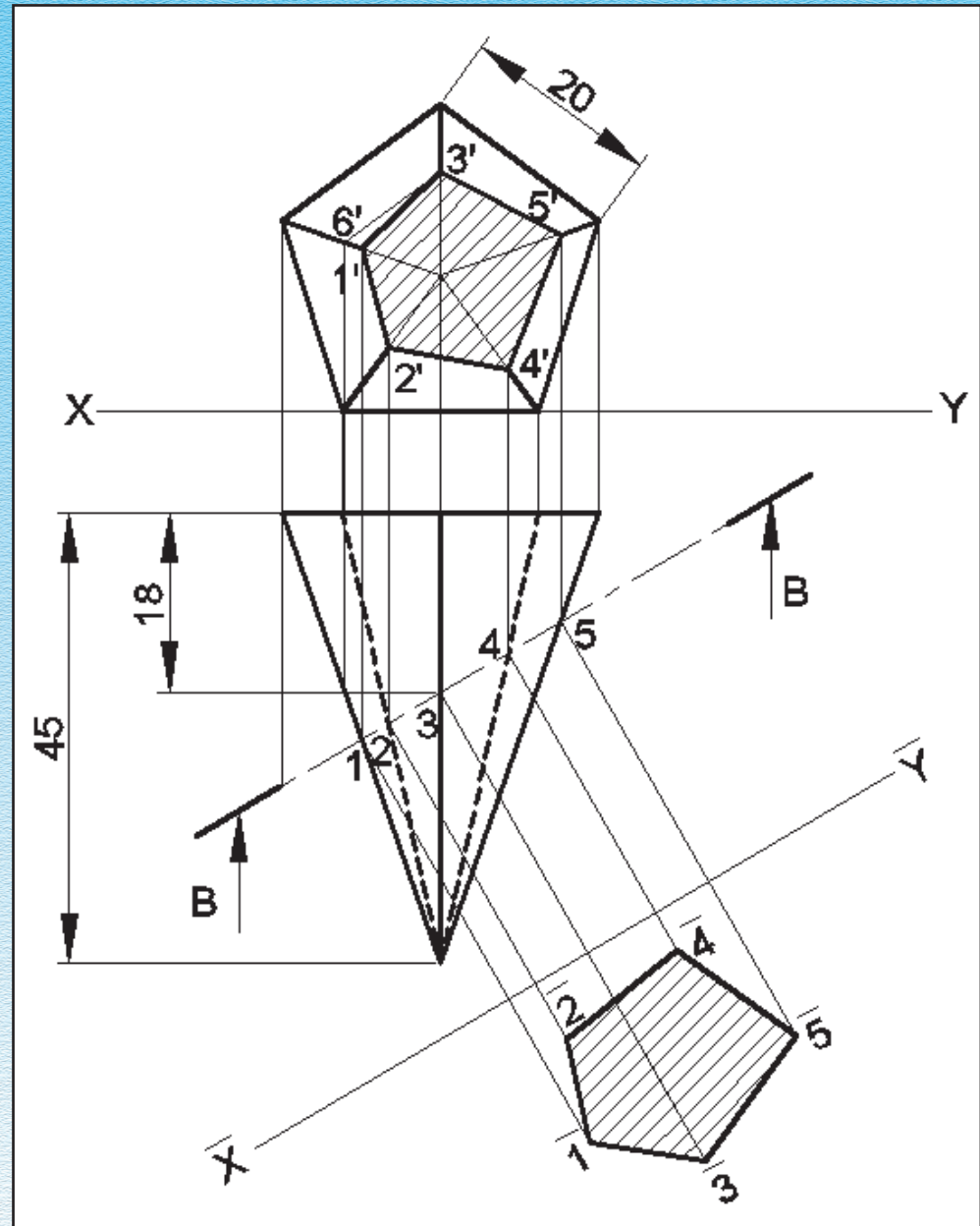


Fig. 5.49

ADDITIONAL QUESTIONS

Example 5.29 : A cone, base 30 mm dia, axis 40 mm long is resting on HP such that the axis is parallel to HP & VP. It is cut by a section plane perpendicular to VP and parallel to one of the generators and passing through a point on the axis at a distance of 15mm from the apex. Draw the sectional Top View, Front View and true shape of the section.

Solution : Refer to Fig. 5.50

1. Draw the Front View with the section plane and corresponding sectional Top View with the helping end/side view as shown.

(It can be noticed pts 6' & 7' can't be projected directly. So they were projected on the end view as 6'' & 7'' on the circle (i.e. base) From the side view it was then projected on the Top View as 6 & 7).

2. Draw the line $\bar{X}-\bar{Y}$ parallel to the section plane C-C and draw projectors (perpendicular lines) to it from the POIs 1', 2', 3', 4', 5', 6' & 7' in the Front View.
3. Mark the distances of the projected POIs, i.e. $\bar{1}, \bar{2}, \bar{3}, \bar{4}, \bar{5}, \bar{6},$ & $\bar{7}$ from

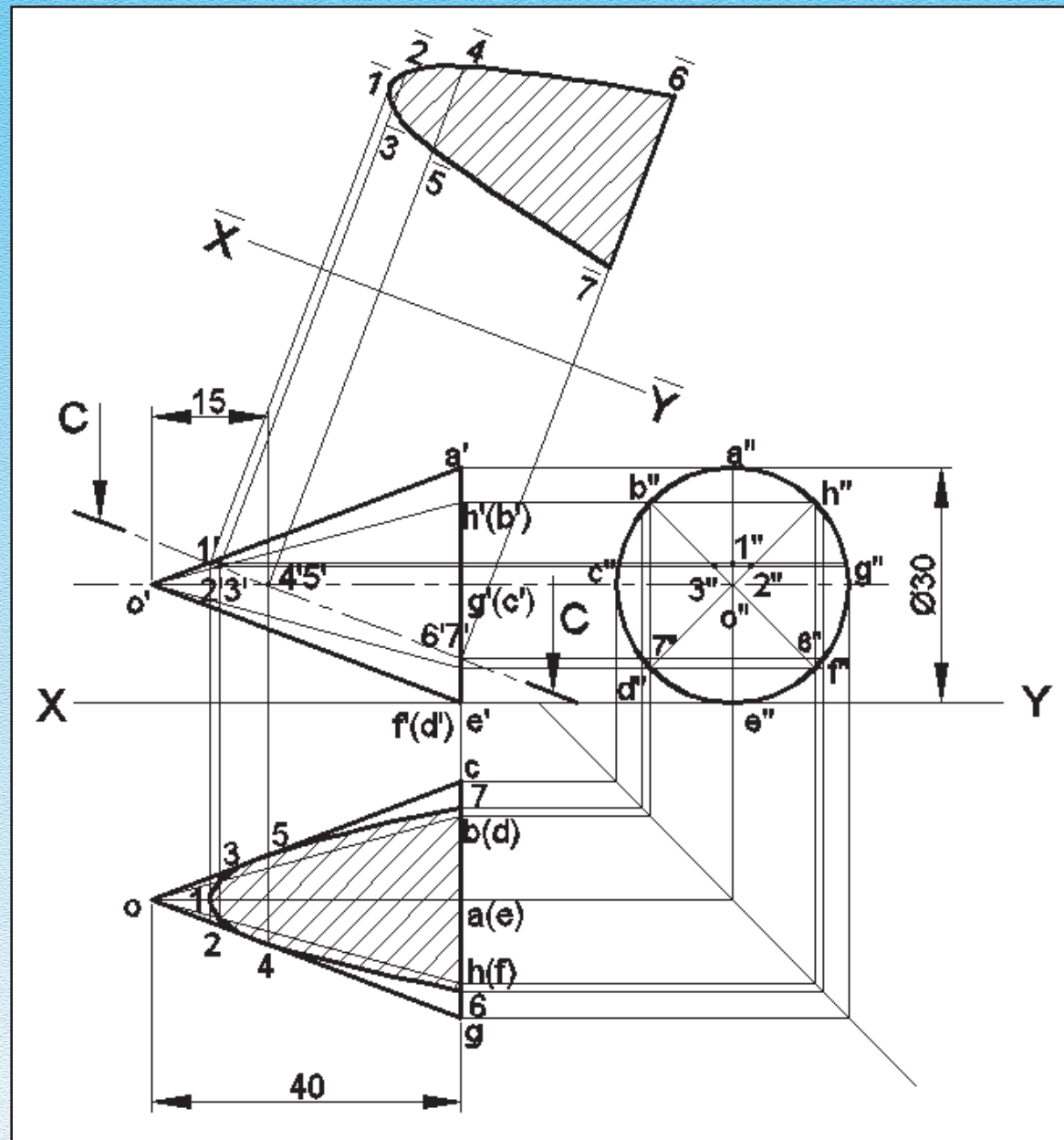


Fig. 5.50

$\bar{X}-\bar{Y}$ equal to the corresponding distances of the points 1, 2, 3, 4, 5, 6 & 7 from X-Y in the Top View.

- Complete the figure in the shape of a parabola and draw section lines in it. This gives the required true shape of the section.

Example 5.30 : A hollow square prism (25 mm base side and 55 mm long axis and thickness 5 mm) rests on its base on HP with the base sides equally inclined to VP. A section plane perpendicular to HP and inclined to VP cuts the prism into two halves. Draw Top View, sectional Front View and true shape of the section.

Solution : Refer to Fig. 5.51

- Draw the orthographic projections of the solid in the given position along with its sectional

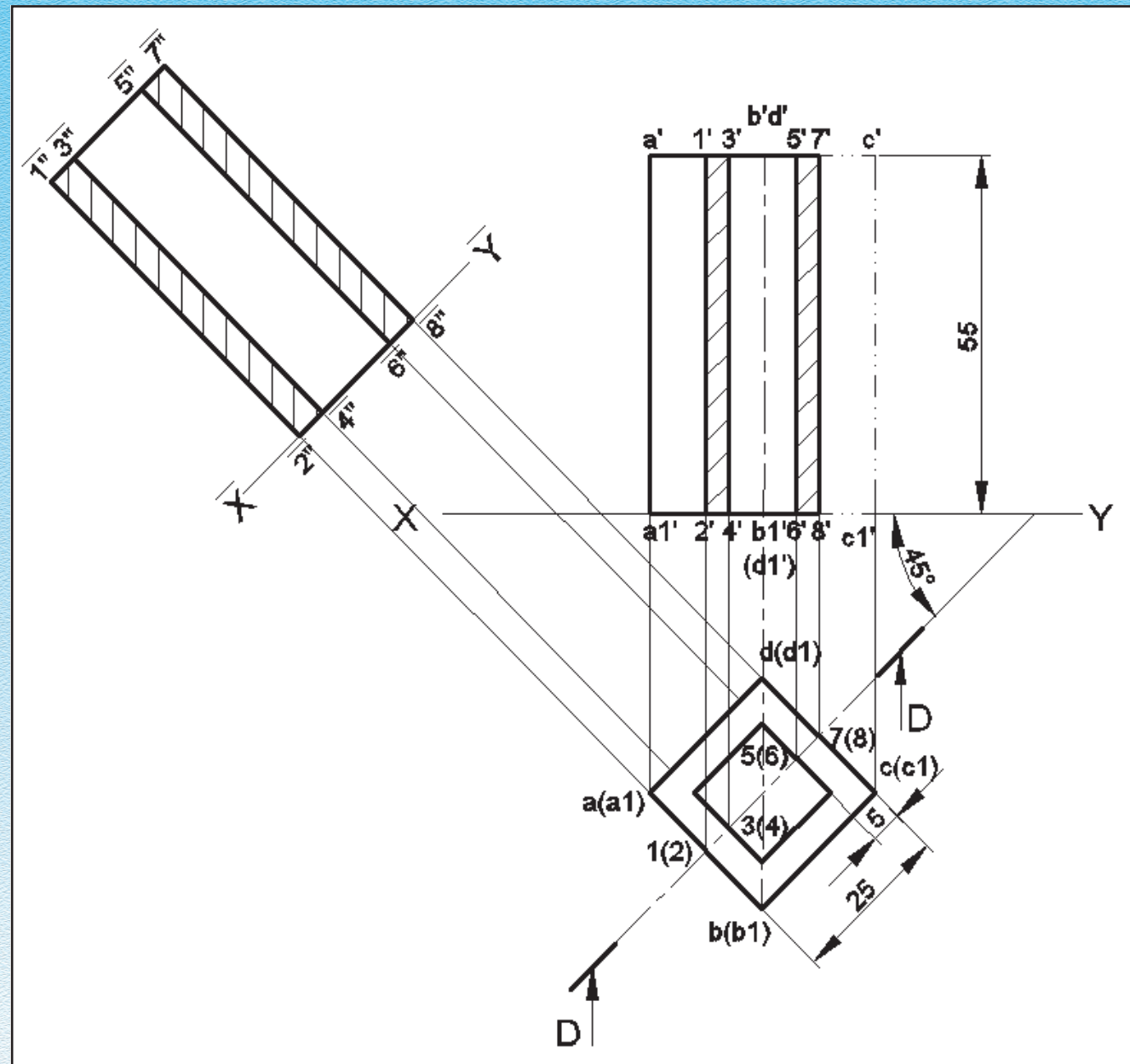


Fig. 5.51

view as shown (As it is hollow, only that part of the solid, which is cut is sectioned)

2. Draw the reference plane (auxiliary plane) $\bar{X}-\bar{Y}$ parallel to the section plane D-D and draw projectors to it from pts. 1, 2, 3 & 4, 5, 6, 7 & 8 in the Top View.
3. Mark the distances from $\bar{X}-\bar{Y}$ equal to the corresponding distances of the points 1', 2', 3' & 4', 5', 6', 7' & 8' from X-Y line in the Front View.
4. Join the pts. $\bar{1}, \bar{2}, \bar{3}$ & $\bar{4}$ and $\bar{5}, \bar{6}, \bar{7}, \bar{8}$, Section the required area to obtain the true shape of the section. (Remember spaces are not hatched, only the cut portion of the solid is hatched and hatching should also be identical for the same solid.

Example 5.31 : A hexagonal frustum (top base side 20 mm, bottom base side = 30 mm and height = 70 mm) rests on one of its base corners such that the bottom hexagonal face makes an angle of 30° with HP. A sectional plane, inclined at 60° to VP and perpendicular to HP, bisects the axis. Draw the sectional Top View, Front View and true shape of the section.

Solution : Refer to Fig. 5.52

1. Draw the projections of the frustum of the horizontal pyramid in the given position as learnt in the previous chapter. Draw the section plane and the respective sectional view in Front View as shown.
2. Draw the line $\bar{X}-\bar{Y}$ parallel to the section plane E-E and draw projectors.
3. Mark the distances from $\bar{X}-\bar{Y}$ equal to the corresponding distances of points 1, 2, 3, 4, 5 & 6 from X-Y in the Top View.
4. Join pts. $\bar{1}, \bar{2}, \bar{3}, \bar{4}, \bar{5}, \bar{6}$ and draw section lines in it. This is the true shape.

TRY THESE

- Fill in the blanks
 - (a) True shape can be obtained on a plane _____ to the section plane
 - (b) The true shape of a section of a sphere which is cut by an inclined section plane at some distance from the axis is _____
 - (c) When a vertical pentagonal pyramid is cut by a horizontal section plane, the true shape will be _____ .

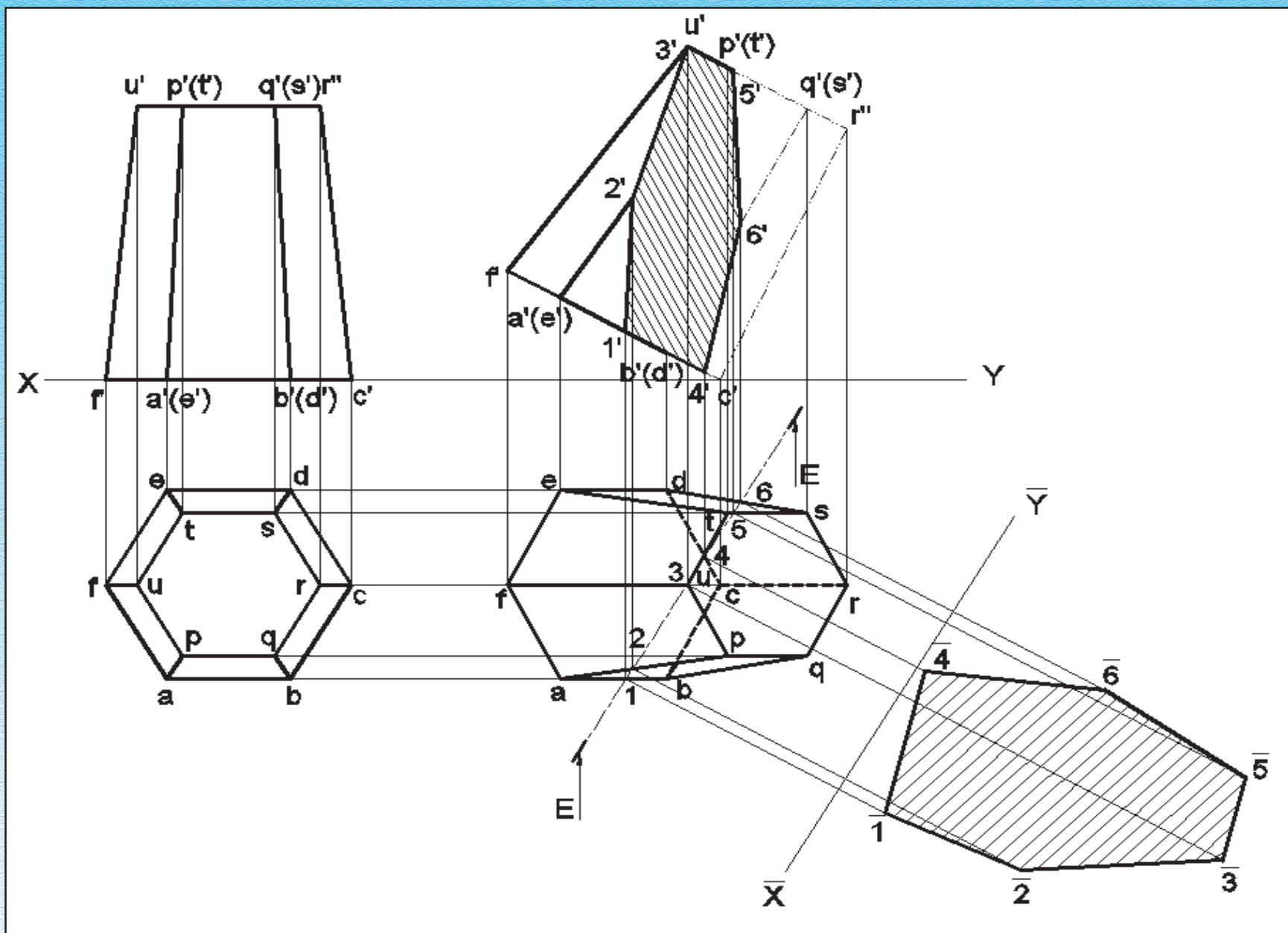


Fig. 5.52

- II. A Front View and incomplete Top View of a pentagonal pyramid is shown in Fig. 5.53 (a) The pyramid is cut by a section plane A-A inclined at 30° to HP. Draw the Front View, complete the Top View and add sectional view and true shape of the section.

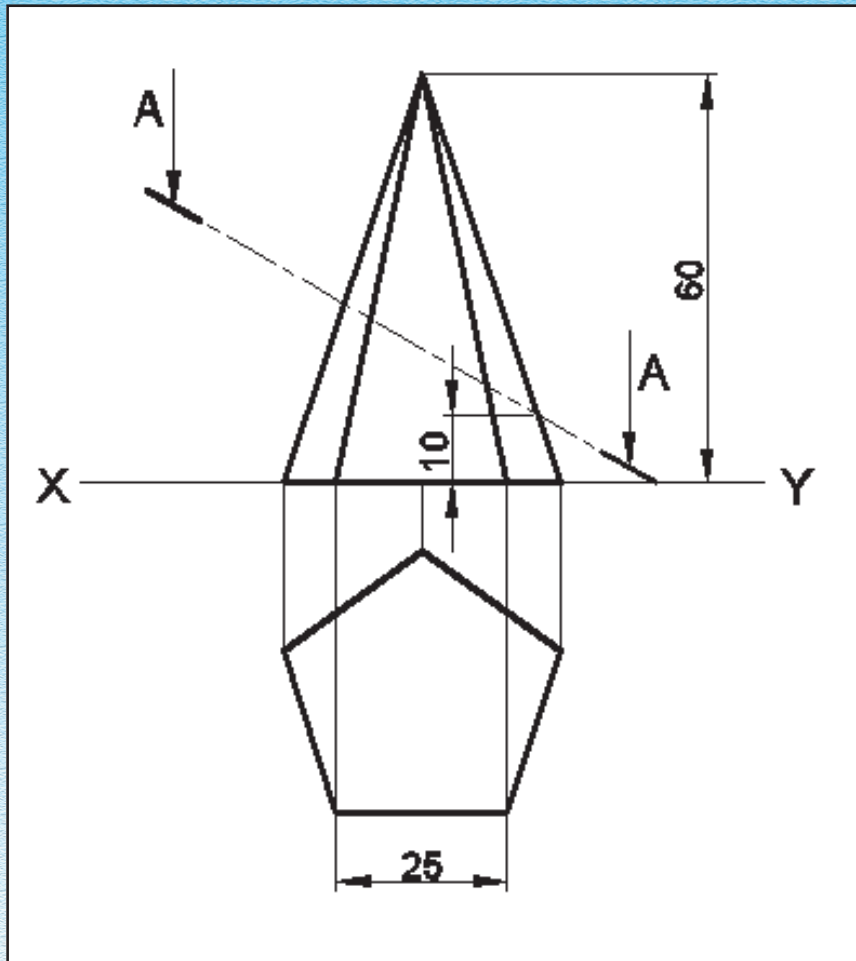


Fig. 5.53a

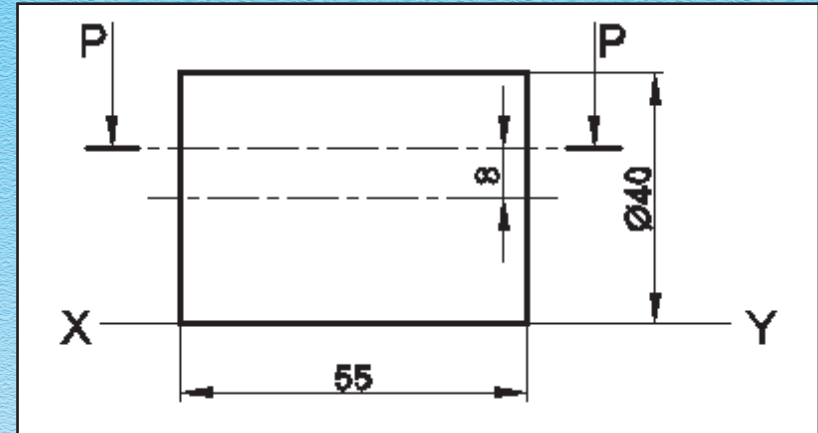


Fig. 5.53b

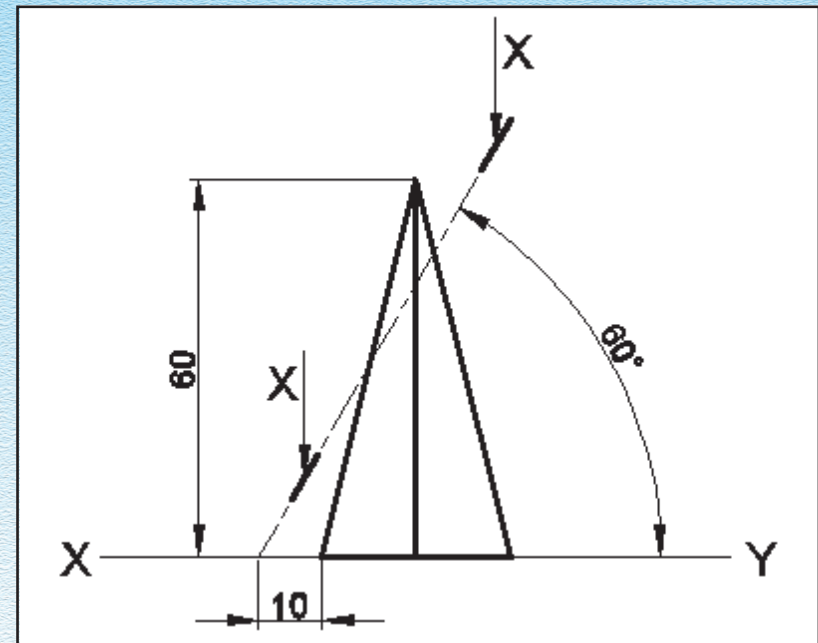


Fig. 5.53c

- III. A Front View of a regular hexagonal pyramid of base edge length 20 mm is cut by a section plane X-X as shown in Fig. 5.53 (b). Draw the Front View, Top View with section and its true shape.
- IV. A cylinder is shown resting on HP and cut by a section plane P-P, in Fig. 5.53 (c) Draw the given Front View, and the sectional Top View. Obtain the true shape of the section.

WHAT WE HAVE LEARNT

- 1. To show interior complicated details (spaces, materials etc.) and help in understanding, interpretation of drawings, the method of sectioning is adopted.
- 2. The solid is imagined to be cut (sectioned) by a plane called the section plane (cutting plane).
The arrowheads indicate the direction of viewing.
- 3. The surface obtained by cutting the object is called section. And it is represented by thin equidistant lines (section lines) usually drawn (hatched) at 45° .
- 4. The portion of the solid which lies between the cutting plane and the observer is assumed to be removed as is represented as _____ lines.
- 5. The sectional views are extension of the orthographic projections and contain the section.
- 6. When section plane is parallel/inclined to HP
Sectional Top View is obtained.
When section plane is parallel/inclined to VP.
Sectional Front View is obtained.
- 7. **Procedure to draw sectional views :**
 - (i) Draw the projections of the solid in the required position.
 - (ii) Mark cutting plane as specified and obtain points of intersection (POIs) with the edges.
 - (iii) Project these points on the corresponding edges in the other view.
 - (iv) Join these points and hatch the surface.
 - (v) Draw the remaining projection.

8. **In sectional views :**
 - (i) No section plane is shown
 - (ii) No hidden outline
 - (iii) Hidden lines if necessary
 - (iv) No visible lines inside the section
 9. When section plane is inclined to HP/VP, the section obtained is "apparent"
 10. **True shape of a section** is obtained by projecting the section on an auxiliary reference plane parallel to cutting/section plane.
 11. Procedure to draw true shape :
 - (i) Draw the projections alongwith the sectional view.
 - (ii) Draw (an auxiliary reference plane) line parallel to section plane.
 - (iii) Draw projectors to this plane from POIs & (mark) transfer their respective distances from X-Y on these projectors wrt X"-Y".
 - (iv) Join the pts and hatch the surface.
 12. If section plane is parallel to HP/VP, then their sectional views show the true shape.
- 8.5** A flat surface cut by a section plane gives straight boundary and a curved surface cut by a plane, gives a curved boundary.

ASSIGNMENTS

- I. Choose the correct option :
 - (a) The projection of a cut portion of the solid on HP is called sectional.
 - (i) Top View (ii) Front View (iii) Left side view (iv) Right side view
 - (b) A vertical cone is cut by a horizontal section plane, the resulting cut solid is
 - (i) cone (ii) cylinder (iii) frustum (iv) hemisphere.
 - (c) Under what conditions, the 'sectional Top View' and true shape of the section will be identical.
 - (i) When the cutting plane is parallel to HP & perpendicular to VP
 - (ii) When the cutting plane is perpendicular to HP & parallel to VP
 - (iii) When the cutting plane is parallel to both HP & VP
 - (iv) When the cutting plane is perpendicular to both HP & VP

- (d) A cylinder of height equal to its base radius, is cut by a plane parallel to its axis and passing through the axis, the section surface will be
(i) Circle (ii) Ellipse (iii) Square (iv) Rectangle.
- (e) Which of the following object gives a circular section, when it is cut completely by a section plane (irrespective of the angle of section plane)
(i) Cylinder (ii) Sphere (iii) Cone (iv) Circular Lamina
- (f) Shape of the section obtained when a cone is cut by a plane passing through the apex and center of the base of the cone is
(i) Parabola (ii) Circle (iii) Ellipse (iv) Triangle
- (g) When a regular hexagonal prism is cut by a plane parallel to the axis at some distance from it, the shape of the section is
(i) Regular hexagon (ii) Irregular hexagon (iii) Octagon (iv) Rectangle
- (i) A hexagonal pyramid of 30 mm side and length of axis = 50 mm rests on HP, with one of its base edges parallel to V.P. A cutting plane parallel to VP cuts the solid 10 mm in front of the vertical axis. Draw the sectional Front View and Top View of the pyramid.
- (ii) A right regular square pyramid, side of base 55 mm and height 70 mm, lies on one of its triangular faces upon ground, such that its axis is parallel to VP. A section plane parallel to HP cuts the axis at its midpoint. Draw its Front View and sectional Top View.
- (iii) A pentagonal pyramid, side of base 30 mm and height 50 mm is resting on HP, keeping the axis vertical and a base edge perpendicular to VP. A horizontal cutting plane cuts the solid at a height of 25 mm from the base. Draw Front View and sectional Top View of the pyramid.
- (iv) A pentagonal prism with a 25 mm base side and 65 mm height is resting on its base on HP with a side of base inclined at 30° to VP. A section plane inclined at 60° to HP and passing through the midpoint of the axis cuts the prism. Draw Front View, sectional Top View and true shape of the section.
- (v) A hexagonal prism with a base side of 24 mm and an axis of 55 mm, is resting on an edge of the base on HP with the axis inclined at 60° to HP and parallel to VP. A section plane inclined at 45° to VP and passing through a point on the axis at a distance of 25 mm from the top end cuts the prism. Draw the sectional Top View, Front View and true shape of the section.

- (vi) A cone, base 50 mm diameter and axis 60 mm long has its axis parallel to VP and inclined at 45° to HP. It is cut by a horizontal section plane passing through the mid-point of the axis. Draw Front View, sectional Top View and true shape of the section.
- (vii) A cylinder is resting on its base on HP. It is cut by a plane inclined at 60° to HP, cutting the axis at a point 20 mm from the top. If the diameter of the cylinder = 40 mm and length 65 mm, draw their projections (Front View and sectional plan) and true shape of section.
- (viii) A sphere of ϕ 50 mm rests on HP. A section plane perpendicular to HP, inclined at 45° to VP and at a distance of 10 mm from its centre cuts the sphere. Draw the Top View, sectional Front View and true shape of the section.
- (ix) A triangular pyramid with 45 mm base side and 70 mm slant height, has its base on HP and a side of base perpendicular to VP. It is cut by a section plane inclined at 60° to VP and intersecting the axis at 35 mm from its base. Draw Front View, sectional Top View and the true shape of the section.
- (x) A cone of base dia 42 mm and axis 54 mm long is resting on its base on HP. It is cut by a vertical section plane, inclined at an angle of 60° with the X-Y line and is 10 mm away from the Top View of the axis. Draw Top View, sectional Front View and true-shape of the section.

ANSWERS

5.2. Pg. 4 III(a) ; (b) sectional; (c) 45°

5.3 Pg. 19 1(a) parallel, (b) Circle; (c) Pentagon

ASSIGNMENTS Pg. 21 i (a) ii (b) iii (c) (d) iii (e) ii (f) iv (g) i