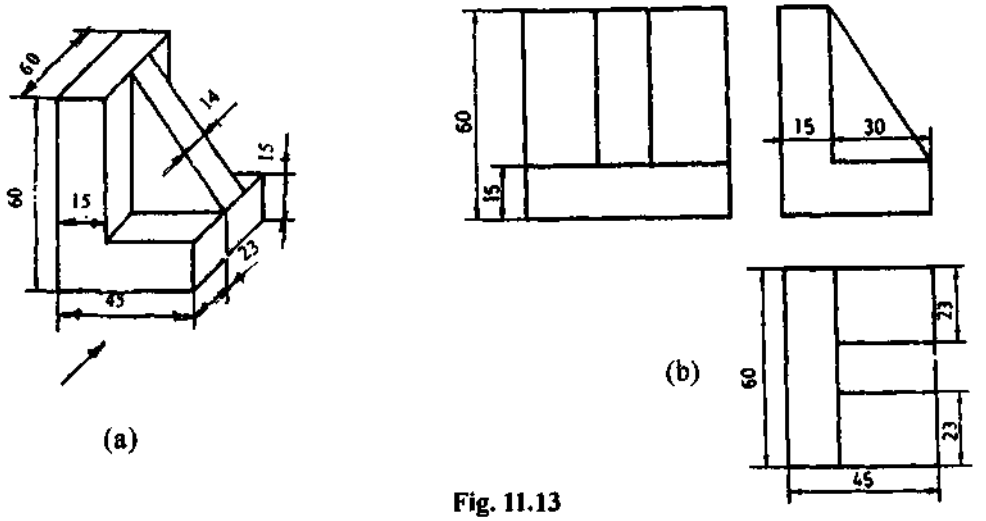


Fig. 11.13

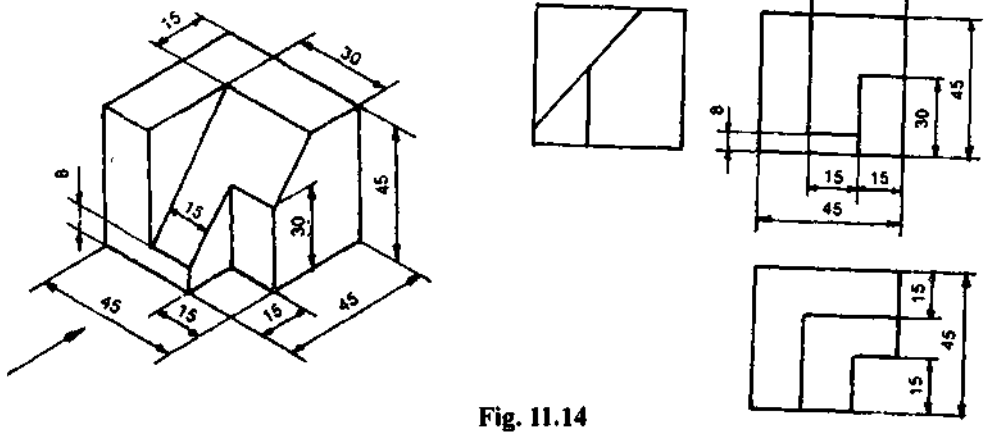


Fig. 11.14

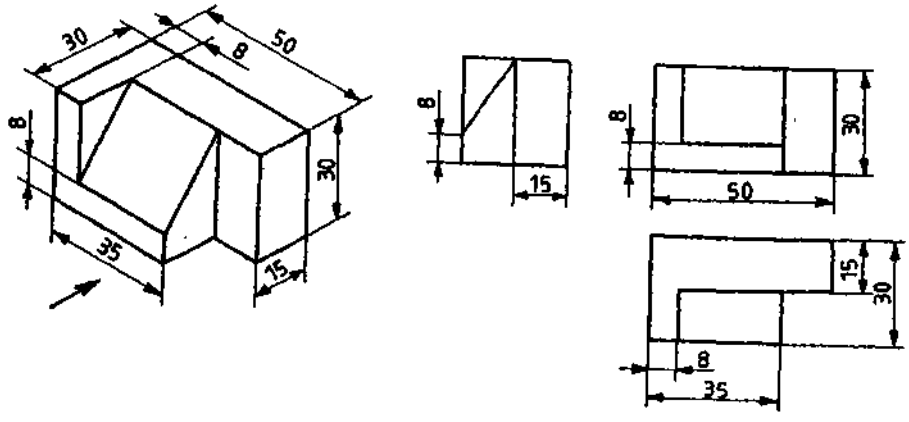


Fig. 11.15

11.3 Conversion of Orthographic Views to Isometric Views

Principles of conversion of orthographic views into isometric views are explained in chapter 7.

Examples

A few orthographic views and their isometric drawing are shown from Fig.11.16 to Fig.11.20.

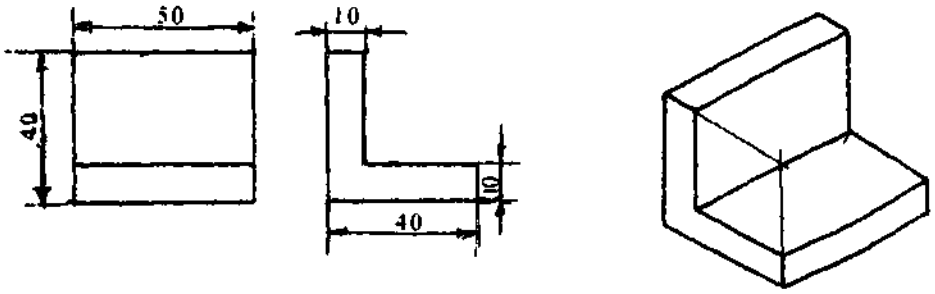


Fig. 11.16

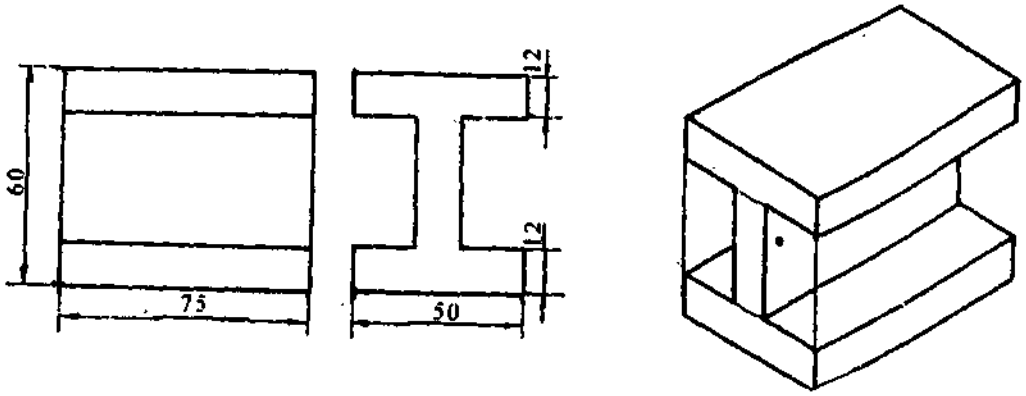


Fig. 11.17

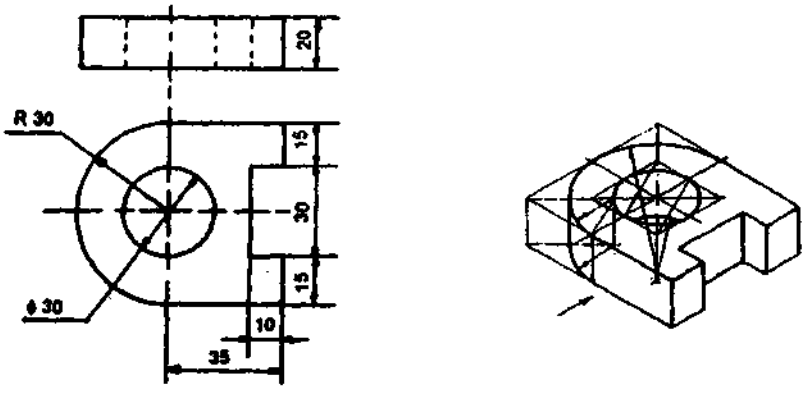
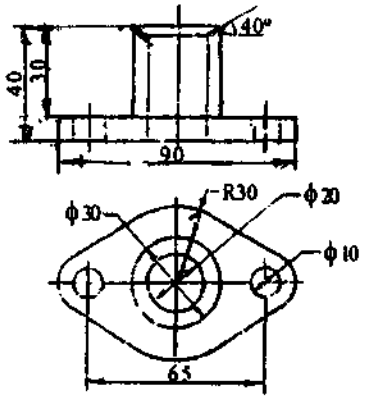


Fig. 11.18



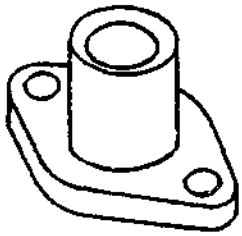
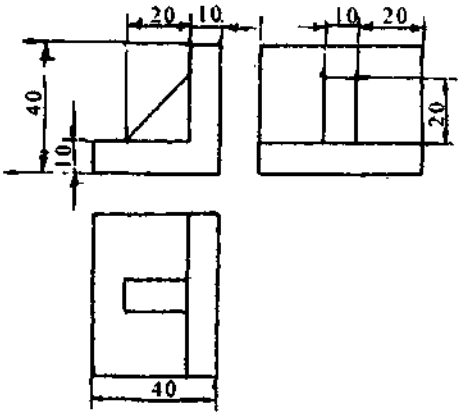


Fig. 11.19



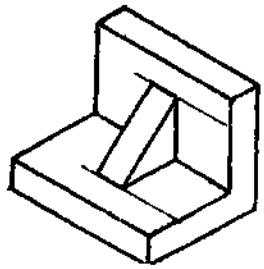


Fig. 11.20

CHAPTER 12

Sections of Solids

12.1 Sectioning of solids

12.1.1 Introduction

Sections and sectional views are used to show hidden detail more clearly. They are created by using a cutting plane to cut the object.

A section is a view of no thickness and shows the outline of the object at the cutting plane. Visible outlines beyond the cutting plane are not drawn.

A sectional view, displays the outline of the cutting plane and all visible outlines which can be seen beyond the cutting plane.

Improve visualization of interior features.Section views are used when important hidden details are in the interior of an object.These details appear as hidden lines in one of the orthographic principal views; therefore, their shapes are not very well described by pure orthographic projection.

12.1.2 Types of Section Views

- Full sections
- Half sections
- Offset sections
- Revolved sections
- Removed sections
- Broken-out sections

12.1.3 Cutting Plane

- Section views show how an object would look if a cutting plane (or saw) cut through the object and the material in front of the cutting plane was discarded

Representation of cutting plane

According to drawing standards cutting plane is represented by chain line with alternate long dash and dot. The two ends of the line should be thick.

Full Section View

- In a full section view, the cutting plane cuts across the entire object
- Note that hidden lines become visible in a section view

Hatching

On sections and sectional views solid area should be hatched to indicate this fact. Hatching is drawn with a thin continuous line, equally spaced (preferably about 4mm apart, though never less than 1mm) and preferably at an angle of 45 degrees.

(i) Hatching a single object

When you are hatching an object, but the objects has areas that are separated, all areas of the object should be hatched in the same direction and with the same spacing.

(ii) Hatching Adjacent objects

When hatching assembled parts, the direction of the hatching should ideally be reversed on adjacent parts. If more than two parts are adjacent, then the hatching should be staggered to emphasise the fact that these parts are separate.

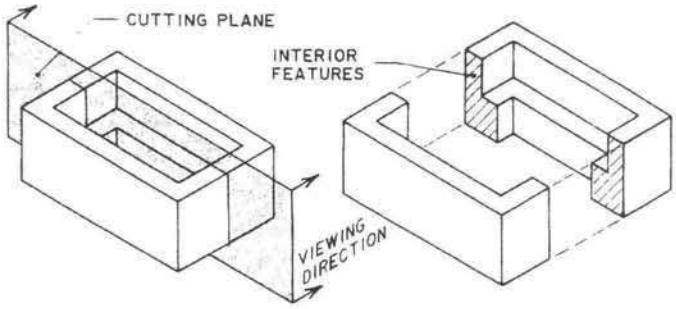


Fig. 12.1

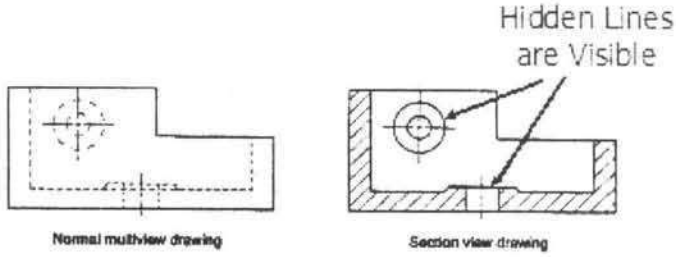


Fig. 12.2

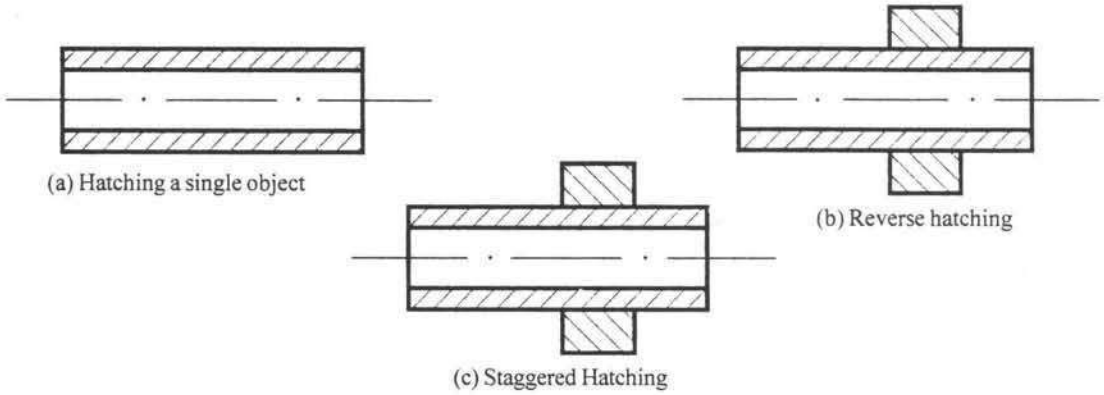


Fig. 12.3

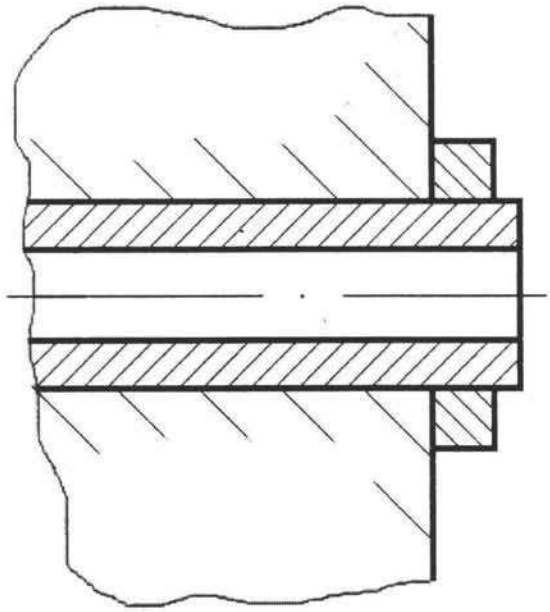


Fig. 12.4 Hatching large areas

EXAMPLES

Problem 1 : A square prism of base side on 30 mm and axis length 60 mm is resting on HP on one of its bases, with a base side inclined at 30° to VP. It is cut by a plane inclined at 40° to. HP and perpendicular to VP and is bisecting the axis of the prism. Draw its front view, sectional top view and true shape of section.

Solution : Draw the projections of the prism in the given position. The top view is drawn and the front view is projected.

To draw the cutting plane, front view and sectional top view

1. Draw the Vertical Trace *(VT)* of the cutting plane inclined at 40° to *XY* line and passing through the mid point of the axis.
2. As a result of cutting, longer edge a' p' is cut, the end a' has been removed and the new corner l' is obtained.
3. Similarly 2' is obtained on longer edge b' q', 3' on c' r' and 4' on d' s',
4. Show the remaining portion in front view by drawing dark lines.
5. Project the new points 1', 2', 3' and 4' to. get 1, 2, 3 and 4 in the top view of the prism, which are coinciding with the bottom end of the longer edges p, q, r and s respectively.
6. Show the sectional top view or apparent section by joining 1, 2, 3 and 4 by drawing hatching lines.

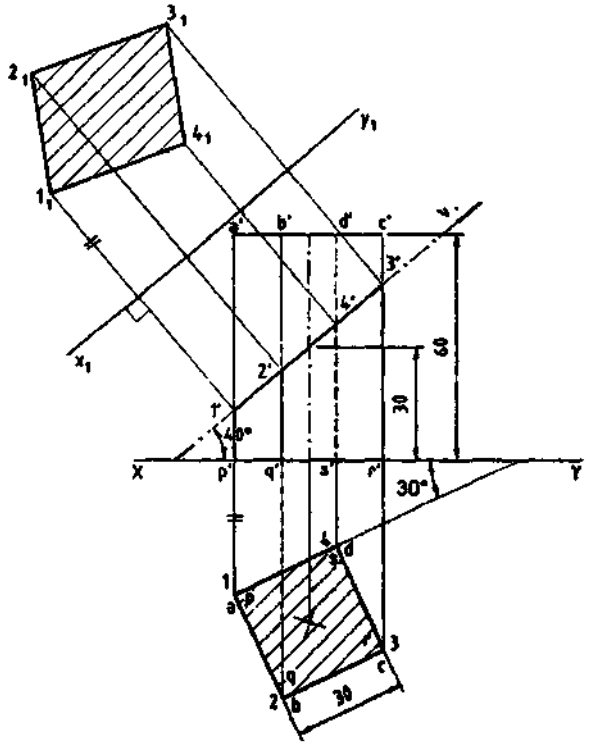


Fig. 12.5

To draw the' true shape of a section

1. Consider an auxiliary inclined plane parallel to the cutting plane and draw the new reference line x_1 y_1 parallel to VT of the cutting plane at an arbitrary distance from it.
2. Draw projectors passing through 1', 2', 3' and 4' perpendicular to x_1 y_1 line.
3. The distance of point 1 in top view from *XY* line is measured and marked from x_1 y_1 in the projector passing through 1' to get 1_1'. This is repeated to get the other points 2_1, 3_1 and 4_1.
4. Join these points to get the true shape of section as shown by drawing the hatching lines.

Problems 2 : A cube of 45 mm side rests with a face on HP such that one of its vertical faces is inclined at 30° to VP. A section plane, parallel to VP cuts the cube at a distance of 15 mm from the vertical edge nearer to the observer. Draw its top and sectional front view.

Solution :

1. Draw the projections of the cube and the Horizontal Trace (*HT*) of the cutting plane parallel to *XY* and 15 mm from the vertical edge nearer to the observer.
2. Mark the new points 1,2 in the top face edge as *ab* and *bc* and similarly, 3, 4 in the bottom face edge as *qr* and *pq* which are invisible in top view.
3. Project these new points to the front view to get 1', 2 '. in top face and 3', 4' in. bottom face.

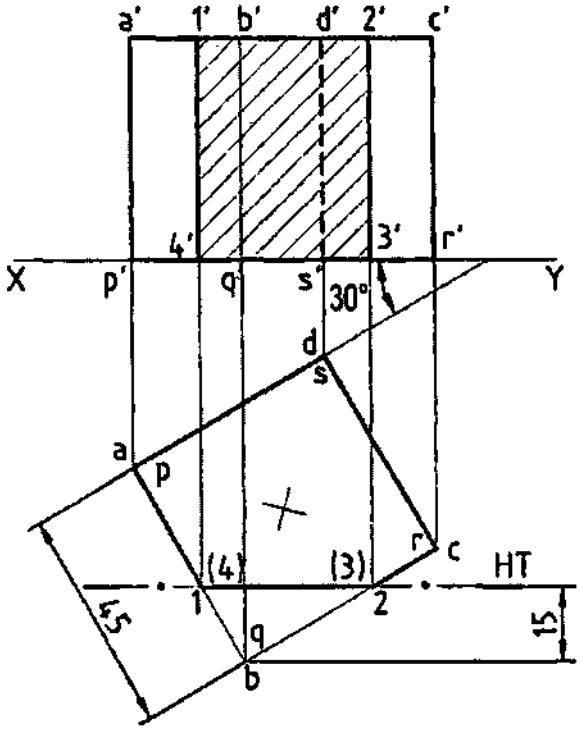


Fig. 12.6

4. Join them and draw hatching lines to show the sectional front view which also shows the true shape of section.

Problem 3 : A pentagonal pyramid of base side 40 mm and axis length 80mm is resting on HP on its base with one of its base side parallel to VP. It is cut by a plane inclined at 30° to HP and perpendicular to VP and is bisecting the axis. Draw its front view, sectional top view, and the true shape of section.

Solution : Draw the projection of the pyramid in the given position. The top view is drawn and the front view is projected.

To draw the cutting plane, front view and sectional top view

1. Draw the *VT* of the cutting plane inclined at 30° to *XY* line and passing through the midpoint of J the axis.
2. As a result of cutting, new corners 1', 2', 3', 4' and 5' are obtained on slant edges *a'o'*, *b'o'*, *c'o'*, *d'o'* and *e'o'* respectively.
3. Show the remaining portion in front view by drawing dark lines.
4. Project the new points to get 1, 2, 3, 4 and 5 in the top view on the respective slant edges .
5. Note that 2' is extended horizontally to meet the extreme slant edge *a'o' at m'*, it is projected to meet *ao* in top view at m. Considering *o* as centre, *om* as radius, draw an arc to get 2 *on bo*.

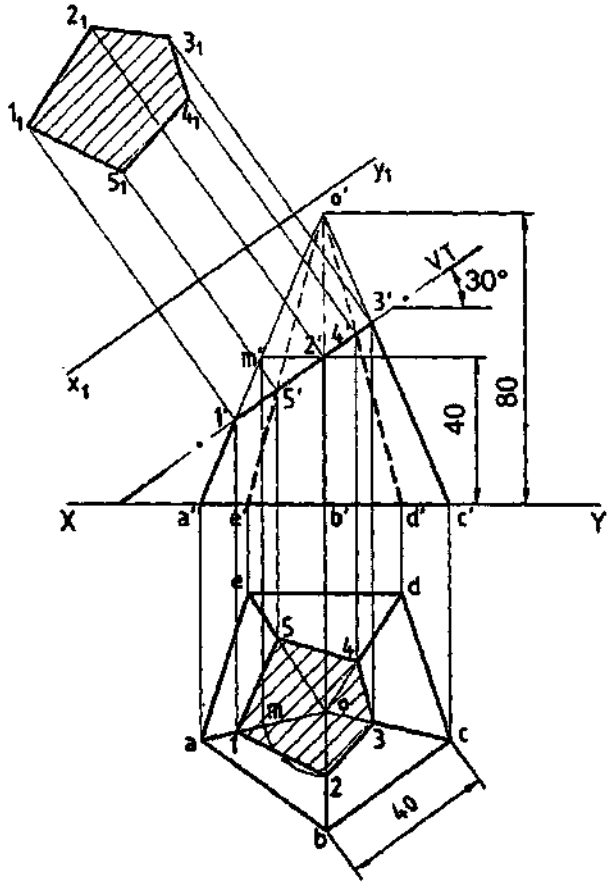


Fig. 12.7

6. Join these points and show the sectional top view by drawing hatching lines. SS

To draw true shape of section.

1. Draw the new reference line x_1 y_1 parallel to *VT* of the cutting plane.
2. Projectors from 1',2' etc. are drawn perpendicular to x_1 y_1 line .
3. The distance of point 1 in top view from *XY* line is measured and marked from x_1 y_1 in the projector passing through 1' to get 1_1' This is repeated to get 2_1,3_1 etc.
4. Join these points and draw hatching lines to show the true shape of section.

Problem 4 : *A hexagonal prism of base side 30 mm and axis length 60 mm is resting on HP on one of its bases with two of the vertical faces perpendicular to VP. It is cut by a plane inclined at 60° to HP and perpendicular to VP and passing through a point at a distance 12 mm from the top base. Draw its front view, sectional top view and true shape of section.*

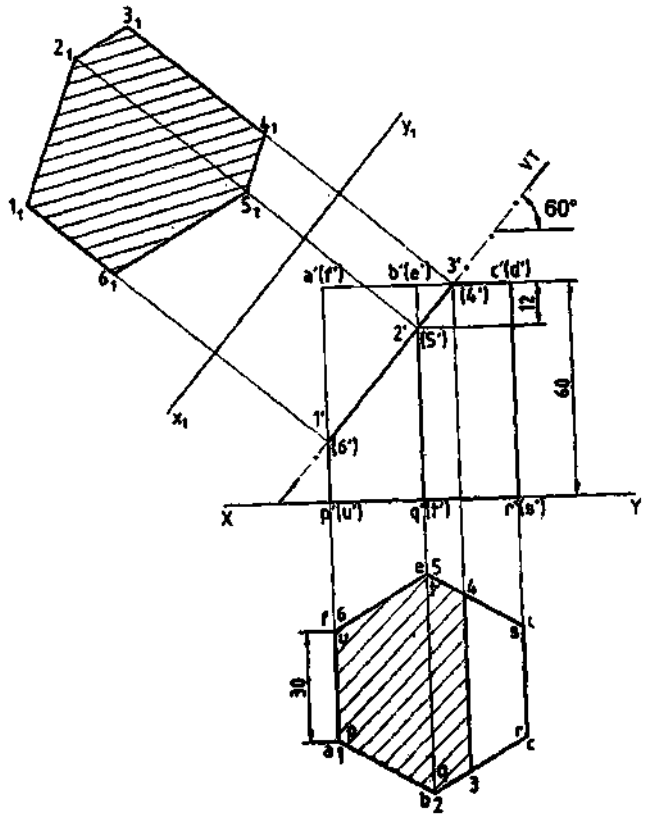


Fig. 12.8

Solution : Draw the projections of the prism in the given position. The top view is drawn and the front view is projected.

To draw the cutting plane, front view and sectional top view

1. Draw the *VT* of the cutting plane inclined at 60° to *XY* and passing through a point in the axis, at a distance 12 mm from the top base.
2. New points 1', 2', etc. are marked as mentioned earlier. Note that the cutting plane cuts the top base, the new point 3' is marked on base side b' c' and 4' marked on (d') (e') which is invisible.
3. Project the new points I', 2', etc. to get 1, 2, etc. in the top view.
4. Join these points and draw the hatching lines to show the sectional top view.

To draw true shape of section

1. Draw new reference line x_1 y_1 parallel to the *VT* of the cutting plane.
2. Draw the projectors passing through 1', 2', etc. perpendicular to x_1 y_1 line.
3. The distance of point 1 in top view from XY line is measured and marked from x_1 y_1 in the projector passing through 1' to get 1_1 This is repeated to get other points 2_1, 3_1 etc.
4. Join these points to get the true shape of section and this is shown by hatching lines.

Problem 5 : A cylinder of base diameter 40 mm and height 60 mm rests on its base on HP. It is cut by a plane perpendicular to VP and inclined at 30° to HP and meets the axis at a distance 30 mm from base. Draw the front view, sectional top view, and the true shape of section.

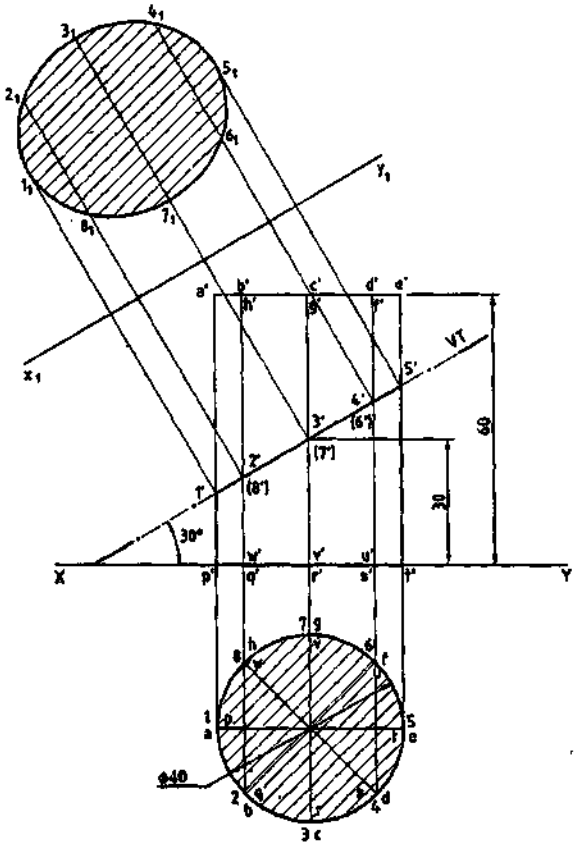


Fig. 12.9

Solution : Draw the projections of the cylinder. The top view is drawn and the front view is projected. Consider generators by dividing the circle into equal number of parts and project them to the front view.

To draw the cutting plane, front view and sectional top view

1. Draw the VT of the cutting plane inclined at 30° to XY line and passing through a point on the axis at a distance 30 mm from base.
2. The new point 1', 2' etc. are marked on the generators $a'p'$, $h'q'$ etc.
3. Project the new points to the top view to get 1, 2, etc. which are coinciding with p, q, etc. on the base circle.
4. Join these points and draw the hatching lines to show the sectional top view.

To draw true shape of section.

1. Draw x_1 y_1 line parallel to *VT* of the cutting plane.
2. Draw the projectors through 1', 2', etc. perpendicular to x_1 y_1 line.
3. The distance of point 1 in top view from *XY* line is measured and marked from x_1 y_1 in the projector passing through 1' to get 1_1. This is repeated to get other points 2_1,3_1 etc.
4. Join these points by drawing smooth curve to get the true shape of section and this is shown by hatching lines.

Problem 6 : A cone of base diameter 50 mm and axis length 75 mm, resting on HP on its base is cut by a plane in lined at 45° to HP and perpendicular to VP and is bisecting the axis. Draw the front view and sectional top view and true shape of this section.

Solution : Draw the projections of the cone. Consider generators by dividing the circle into equal number of parts and project them to the front view.

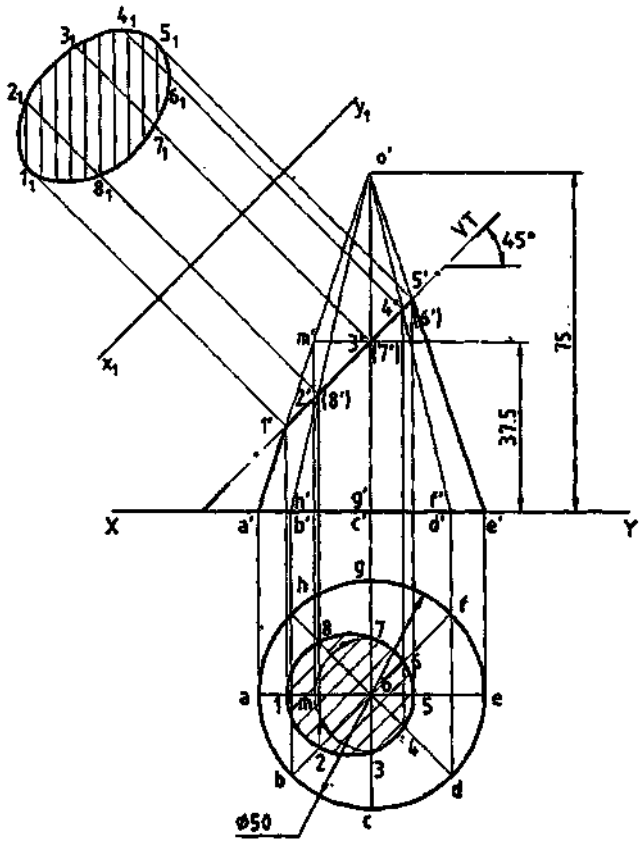


Fig. 12.10

To draw the cutting plane, front view and sectional top view

1. Draw the *VT* of the cutting plane inclined at 45° to the *XY* line and passing through the midpoint of the axis.
2. New points 1', 2' etc; are marked on the generators *a' o'*, *h' o'*, etc.
3. Project the new points to the top view to get 1, 2, etc. on the generators *ao*, *bo* etc.
4. Note that the new point 3' is produced to mark m' on *a' o'* and is projected to get *m* on *ao*. Considering *o* as centre and *om* as radius, draw an arc to get 3 on *co* in the top view. The same method is repeated to get 7 on *go*.
5. Join these points by drawing smooth curve and draw the hatching lines to show the sectional , top view.

To draw true shape of section

1. Draw $x_1 y_1$ line parallel to *VT* of the cutting plane.
2. Draw the projectors through 1', 2' etc. perpendicular to $x_1 y_1$ line.
3. The distance of point 1 in top view from *XY* line is measured and marked from x_1 y_1 in the projector passing through 1' to get 1_1 and is repeated to get 2_1 , 3_1 etc.
4. Join these points by drawing smooth curve to get the true shape of section and is shown by hatching lines.

Problem 7 : A pentagonal prism of base side 30 mm and axis length 60 mm is resting on HP on one of its rectangular faces, with its axis perpendicular to VP. It is cut by a plane inclined at 50° to VP and perpendicular to HP and passing through a point 25 mm from rear base of the prism. Draw its top view, sectional front view and true shape of section.

Solution : To draw the cutting plane, top view and sectional front view

1. Draw the projections of the prism. Draw the *HT* of the cutting plane at 50° to *XY* and passing through the point on the axis at a distance of 25 mm from the rear base.
2. Mark the new points 1 on *ap*, 2 on *bq* etc.
3. Show the remaining portion in top view by drawing dark lines.
4. Project the new point 1, 2, etc. to the front view to get 1', 2' etc. which are coinciding with the rear end of the longer edges *p'*, *q'* etc.
5. Show the sectional front view by joining 1', 2' etc. and draw hatching lines.

To draw the true shape of section

1. Consider an AVP and draw $x_1 y_1$ line parallel to *HT* of the cutting plane.
2. Draw projectors through 1,2 etc. perpendicular to $x_1 y_1$ line.
3. The distance of 1' in front view from *XY* line is measured and marked from x_1 y_1 in the projector passing through 1 to get $1'_1$, and this is repeated to get $2'_1$, $3_1'$, etc.
4. Join them and show the true shape of section by drawing hatching lines.

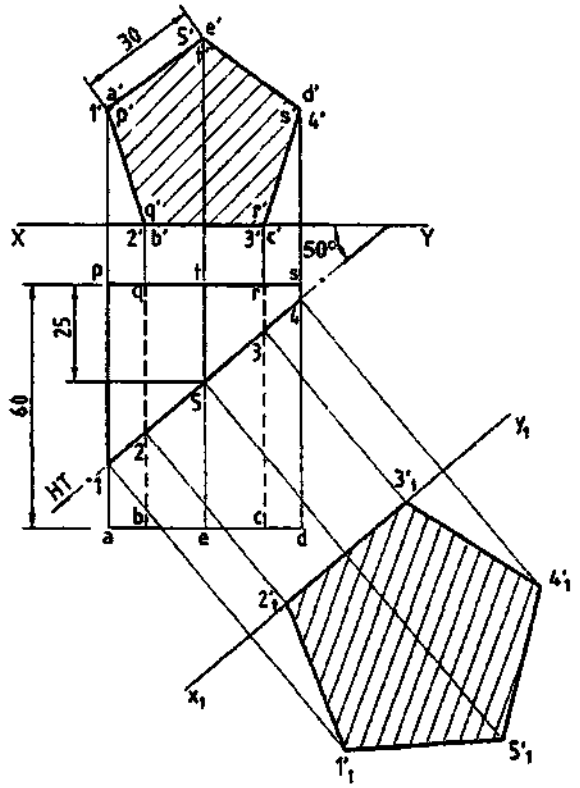


Fig. 12.11

Problem 8 : A cylinder of base diameter 45 and axis length 60 mm is resting on HP on one its generators with its axis perpendicular to VP. It is cut by a plane inclined 30° to VP and perpendicular to HP 'and is bisecting the axis of the cylinder. Draw its top view, sectional front view and true shape of section.

Solution : Draw the projections of the cylinder. Consider generators by dividing the circle into equal number of parts and project them to the top view.

To draw the cutting plane, top view and sectional, front view

1. Draw the *HT* of the cutting plane inclined at 30° to *XY* and passing through the midpoint of the axis.
2. The new points 1, 2, etc. are marked on generators *ap*, *bq*, etc.
3. Project the new points to the front view to get 1', 2' etc. which are coinciding with *p*, *q*, etc. on the base circle.
4. Join them and draw hatching lines to show the sectional front view.

To draw the true shape of section

1. Draw $x_1 y_1$ line parallel to *HT* of the cutting plane.

2. Draw projectors through 1, 2, etc. perpendicular to $x_1 y_1$ line.
3. The distance of 1' in front view from *XY* line is measured and marked from $x_1 y_1$ in the projector passing through 1' to get $1'_1$ and is repeated to get $2'_1, 3'_1$ etc.
4. Join them by drawing smooth curve and show the true shape of section by drawing hatching lines.

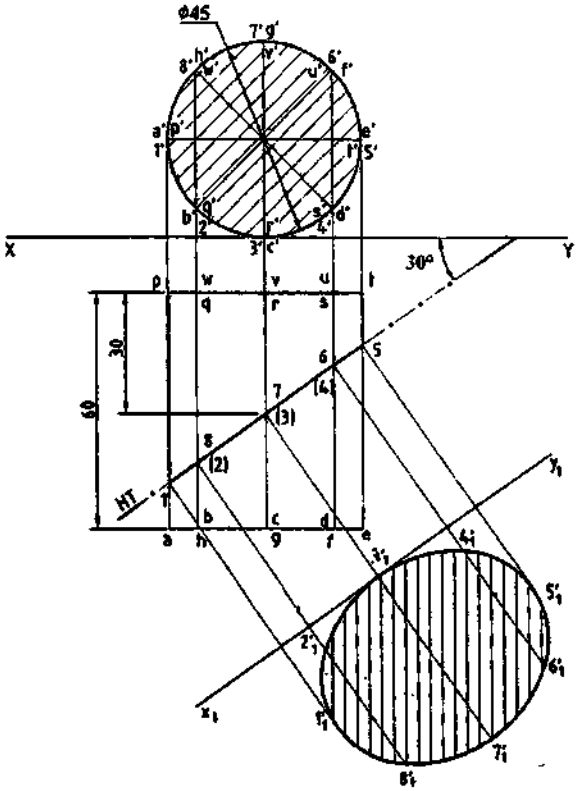


Fig. 12.12

EXERCISES

1. A cube of side 35 mm rests on the ground with one of its vertical faces inclined at 30° to the V.P. A vertical section plane parallel to V.P. and perpendicular to H.P. and at a distance of 35 mm from V.P. cuts the solid. Draw the sectional front view and top view.
2. A regular hexagonal pyramid of side 30 mm and height 65 mm is resting on its base on H.P. one of its base sides is parallel to V.P. It is cut by a cutting plane which is parallel to H.P. and perpendicular to V.P. and passing through at a height of 45 mm from its bottom. Draw its sectional front view and top view.

3. A regular hexagonal prism of side 30 mm and height 70 mm is standing on V.P. with its axis perpendicular to V.P. being one of its rectangular faces parallel to H.P. It is cut by a section plane inclined at 60° to the H.P. perpendicular to V.P. and passing through the mid-point of the bottom side on the front face which is parallel to H.P. Draw its sectional front view and top view. Also draw the true shape.
4. A regular pentagonal prism of side 35 mm and height 75 mm has its base in H.P. and one of the rectangular faces makes an angle of 45° to V.P. It is cut by a section plane inclined at 60° to H.P. perpendicular to V.P. and passing through one of the vertical edges at a distance of 25 mm above the base Draw its

   (a) Sectional front view (b) Sectional top view and (c) True shape.
5. A cone of diameter 60 mm and height 70 mm is resting on ground on its base. It is cut by a section plane perpendicular to V.P. inclined at 45° to H.P. and cutting the axis at a point 40 mm from the bottom. Draw the front view, sectional top view and true shape.
6. A right circular cylinder of diameter 60 mm and height 75 mm rests on its base such that its axis is inclined at 45° to H.P. and parallel to V.P. A cutting plane parallel to H.P. and perpendicular to V.P. cuts the axis at a distance of 50mm from the bottom face. Draw the front view and sectional top view.
7. A regular pentagonal pyramid of side 30 mm and height 60 mm is lying on the H.P. on one of its triangular faces in such a way that its base edge is at right angles to V.P. It is cut by a plane at 30° to the V.P. and at right angle to the H.P. bisecting its axis. Draw the sectional view from the front, the view from above and the true shape of the section.
8. A square pyramid base 50 mm side and axis 75 mm long is resting on the ground with its axis vertical and side of the base equally inclined to the vertical plane. It is cut by a section plane perpendicular to V.P. inclined at 45° to the H.P. and bisecting the axis. Draw its sectional top view and true shape of the section.
9. A hexagonal pyramid of base side 30 mm and height 75 mm is resting on the ground with its axis vertical. It is cut by plane inclined at 30° to the H.P. and passing through a point on the axis at 20 mm form the vertex. Draw the elevation and sectional plane.
10. A cut of 40 mm side rests on the H.P. on one of its faces with a vertical face inclined on 30o to V.P. A plane perpendicular to the H.P. and inclined at 60° to the V.P. cuts the cube 5mm away from the axis. Draw the top view and the sectional front view.
11. A cylinder 40 mm dia. and 60 mm long is lying is the H.P. with the axis parallel to both the planes. It is cut by a vertical section plane inclined at 30° to V.P. so that the axis is cut a point 20 mm from one of its ends. Draw top view, sectional front view and true shape of section.

CHAPTER 13

Freehand Sketching

13.1 Introduction

Freehand sketching is one of the effective methods to communicate ideas irrespective of the branch of study. The basic principles of drawing used in freehand sketching are similar to those used in drawings made with instruments. The sketches are self explanatory in making them in the sequence shown (Fig. 13.1 to 13.14).

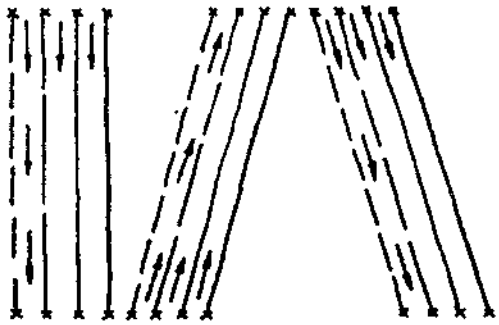


Fig. 13.1 Sketching Straight Lines

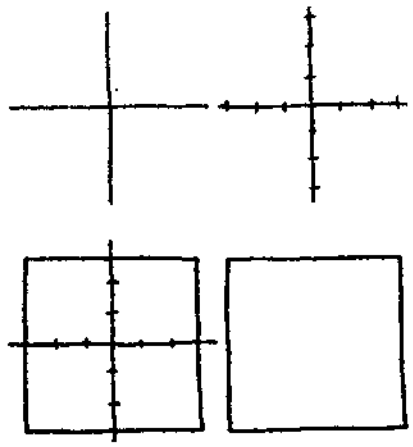
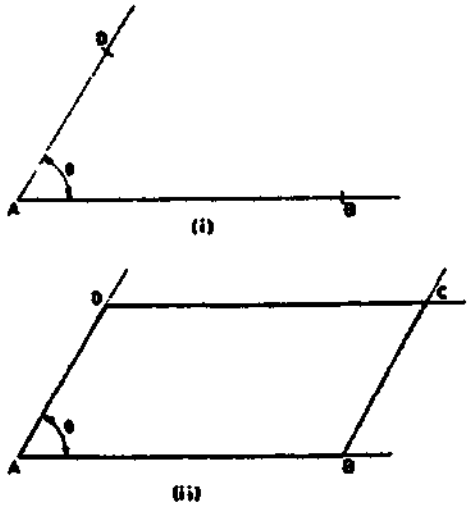
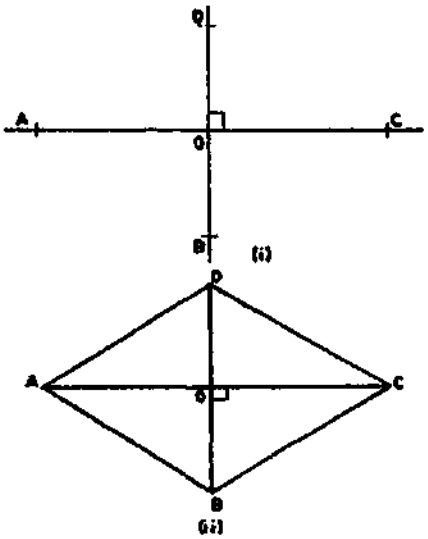


Fig. 13.2 Sketching a Square



a - Sketching a Parallelogram



b - Sketching a Rhombus

Fig. 13.3

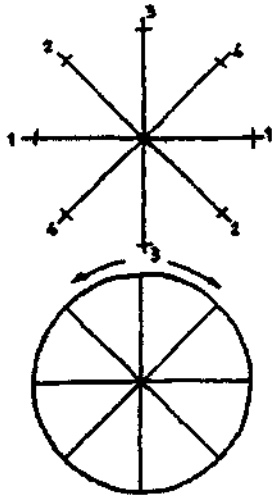


Fig. 13.4 Sketching a Circle

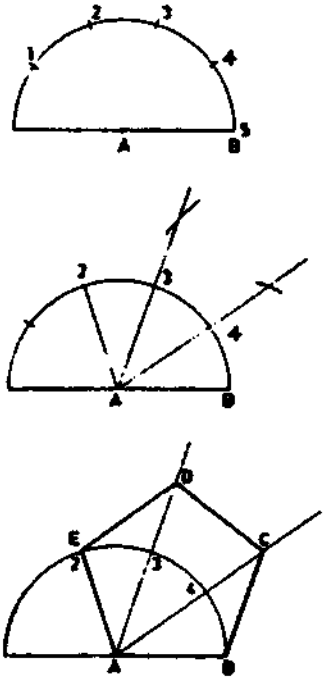


Fig. 13.5 Sketching a Pentagon

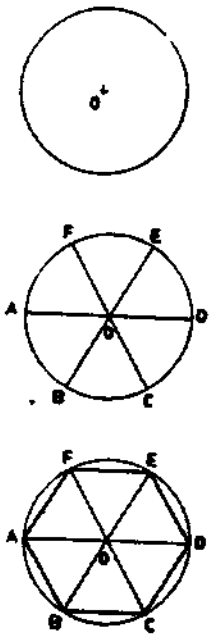


Fig. 13.6 Sketching a Hexagon

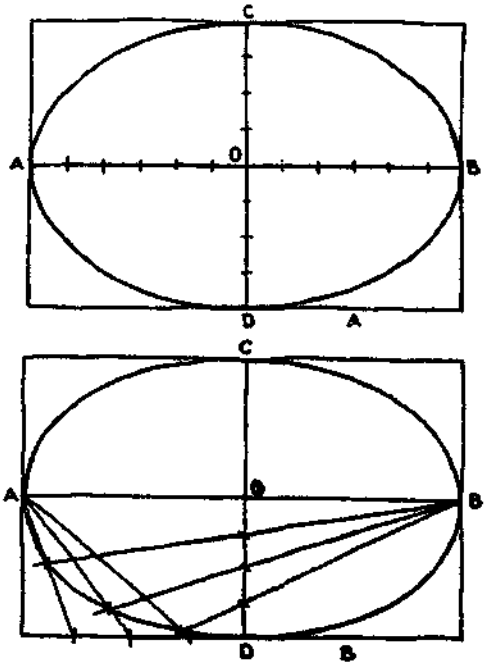


Fig. 13.7 Sketching an Ellipse

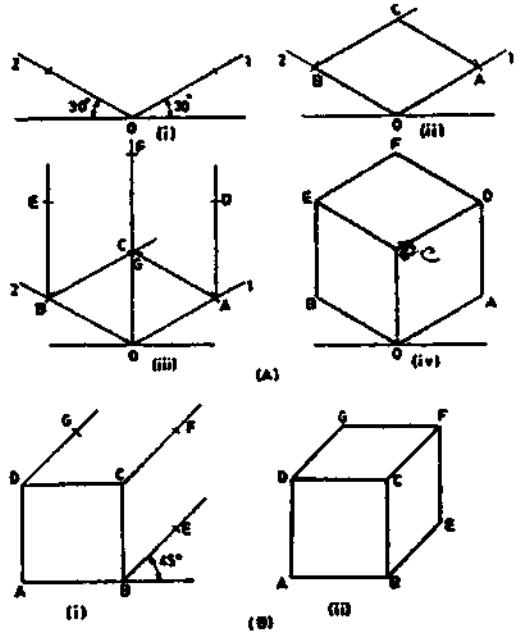


Fig. 13.8 Sketching a Cube

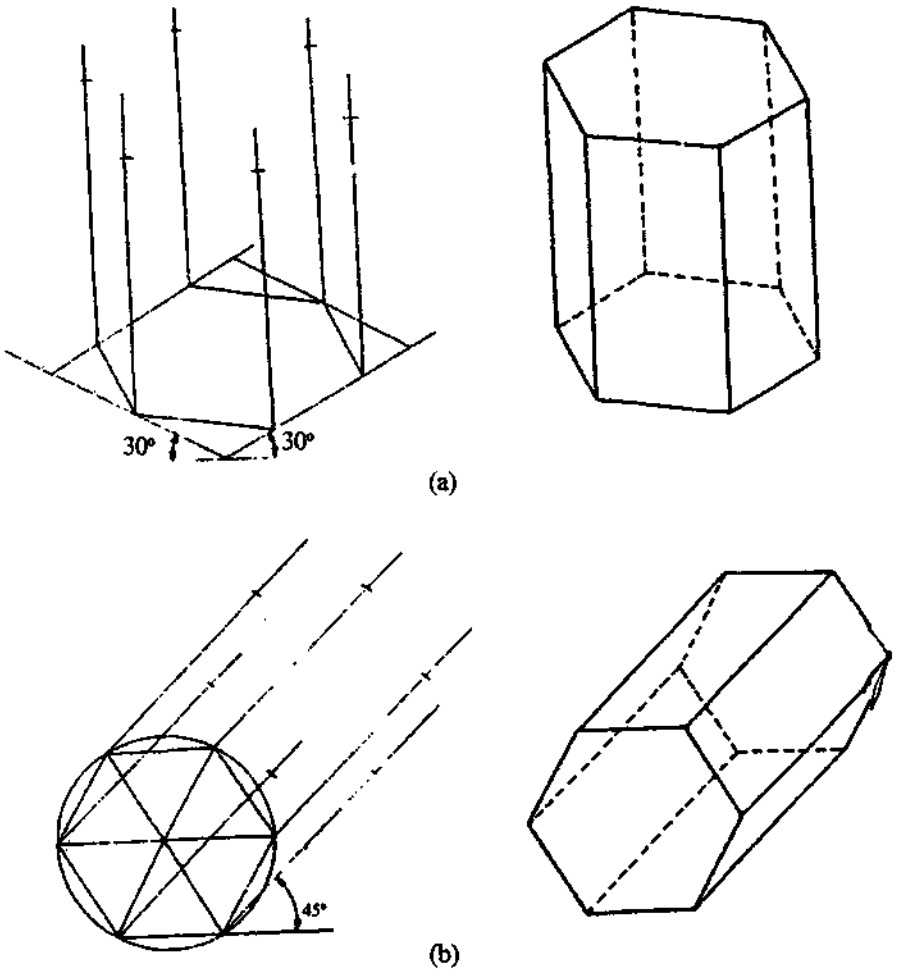
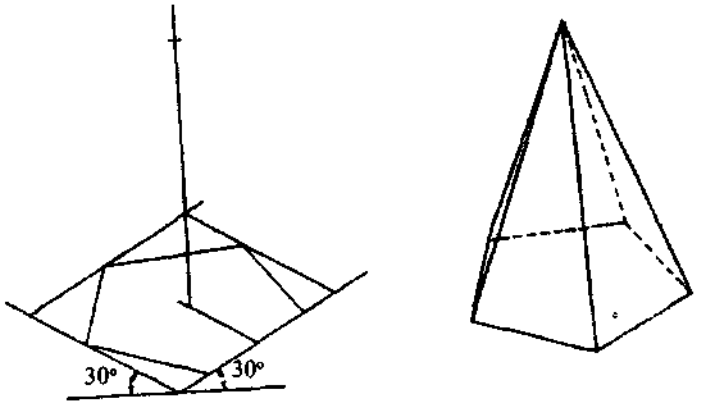
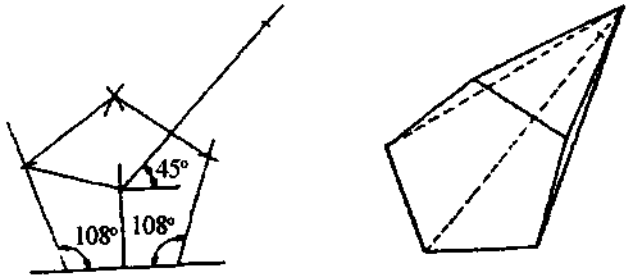


Fig. 13.9 Sketching a Hexagonal Prism



(a)



(b)

Fig. 13.10 Sketching a Pentagonal Pyramid

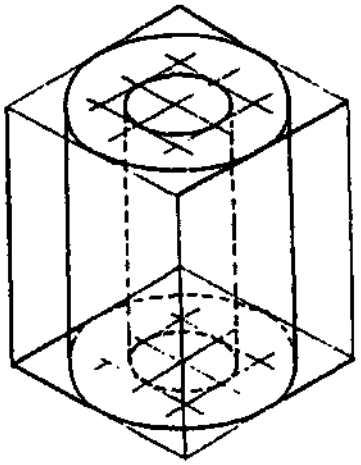


Fig. 13.11 Sketching a Hollow Cylinder

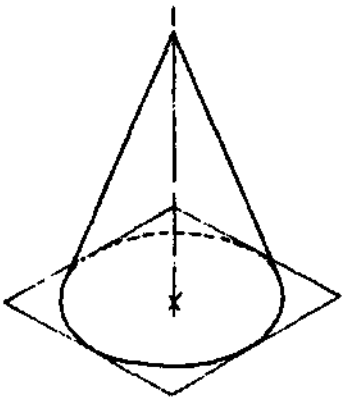


Fig. 13.12 Sketching a Cone

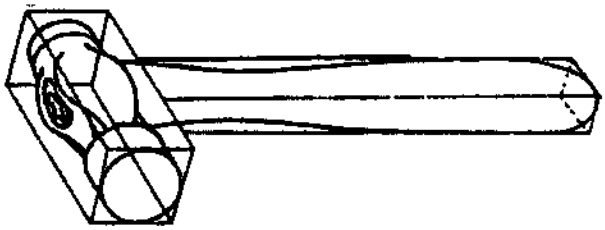


Fig. 13.13 Sketching a Ball Peen Hammer

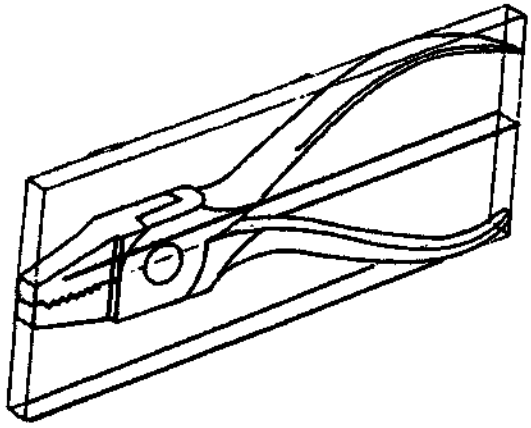


Fig. 13.14 Sketching a Cutting Plier

CHAPTER 14

Computer Aided Design and Drawing (CADD)

14.1 Introduction

In previous chapters we dealt with traditional drawings in which we use essentially drawing board tools such as paper, pencils, drafter, compasses, eraser, scale etc., which will take more time and tough in complex drawings. The most drawback with traditional drawing is INFORMATION SHARING i.e. if an engineer is drawing design of machine component and suddenly the manufacturer to modifies dimension of innermost part of the component; in such situations one cannot modify the drawing already drawn, he should redraw the component.

CADD is an electronic tool that enables us to make quick and accurate drawings with the use of a computer. Drawings created with CADD have a number of advantages over drawings created on a drawing board. CADD drawings are neat, clean and highly presentable. Electronic drawings can be modified quite easily and can be presented in a variety of formats. There are hundreds of CADD programs available in the CADD industry today. Some are intended for general drawing work while others are focused on specific engineering applications. There are programs that enable you to do 2D drawings, 3D drawings, renderings, shadings, engineering calculations, space planning, structural design, piping layouts, plant design, project management, etc.

Examples of CAD software

– AutoCAD, PRO/Engineer, IDEAS, UNIGRAPHICS, CATIA, Solid Works, etc.

14.2 History of CAD

In 1883 Charles Barbage developed idea for computer. First CAD demonstration is given by Ivan Sutherland (1963). A year later IBM produced the first commercial CAD system. Many changes have taken place since then, with the advancement of powerful computers, it is now possible to do all the designs using CAD including two-dimensional drawings, solid modeling, complex engineering analysis, production and manufacturing. New technologies are constantly invented which make this process quicker, more versatile and more Powerful.

14.3 Advantages of CAD

(i) Detail drawings may be created more quickly and making changes is more efficient than correcting drawings drawn manually.

(ii) It allows different views of the same object and 3D pictorial view, which gives better visualization of drawings
(iii) Designs and symbols can be stored for easy recall and reuse.
(iv) By using the computer, the drawing can be produced with more accuracy.
(v) Drawings can be more conveniently filed, retrieved and transmitted on disks and tape.
(vi) Quick Design Analysis, also Simulation and Testing Possible.

14.4 Auto Cad Main Window

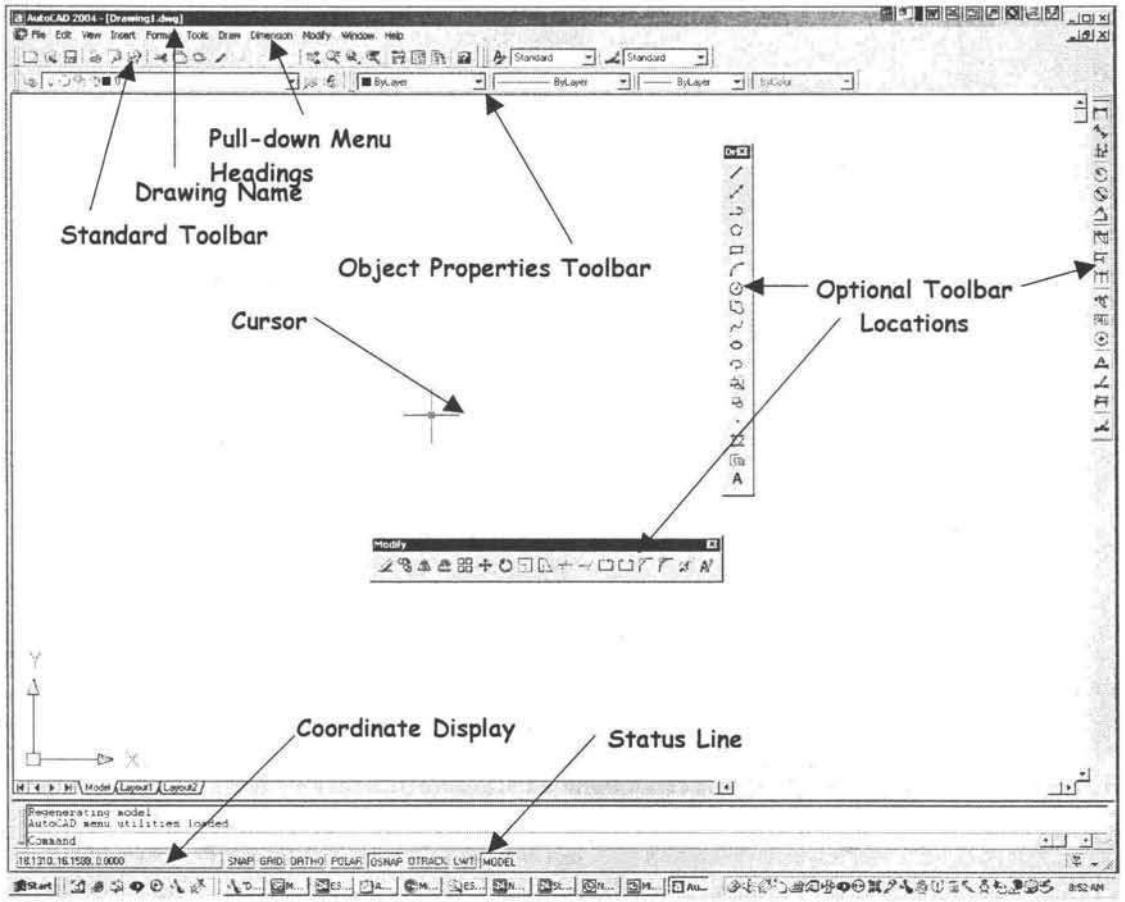


Fig. 14.1

14.4.1 Starting a New Drawing

Select NEW file from pull-down or Toolbar

File>New

Startup dialog box will be opened, with four Options

- Open an existing drawing
- Start from scratch

- Use a template
- Use a Wizard

Select *Start from Scratch* , Click on *Metric(millimetres).*

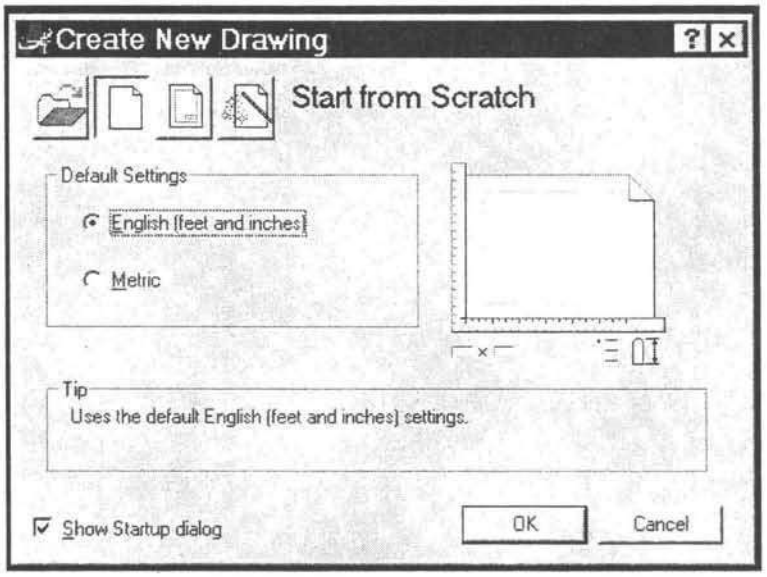


Fig. 14.2

14.4.2 Opening an Existing Drawing

Choose OPEN from FILE pull-down or use opening an existing drawing in the start-up dialogue

Note: Drawing files have extensions of .dwg

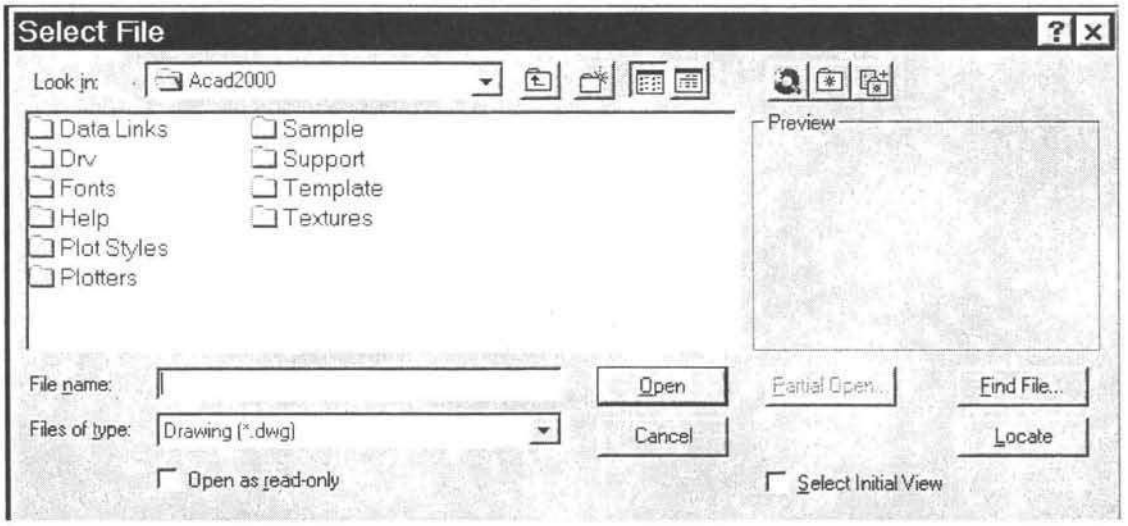


Fig. 14.3