Study the Isometric Views in Figs. 1 to 24 and draw the Orthographic Views required.

Arrow indicates the direction of view.

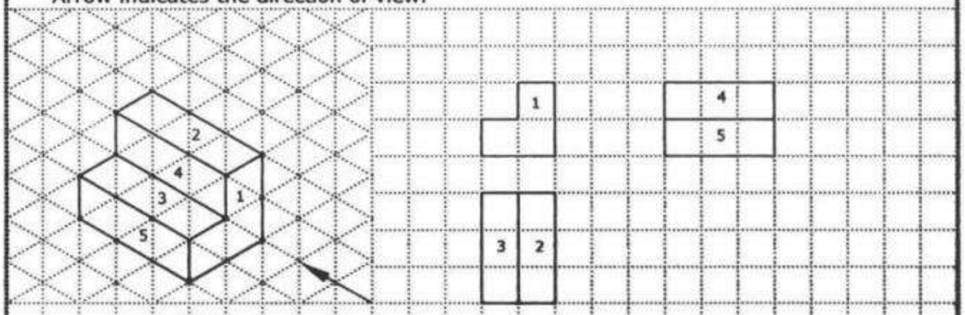


Fig.1

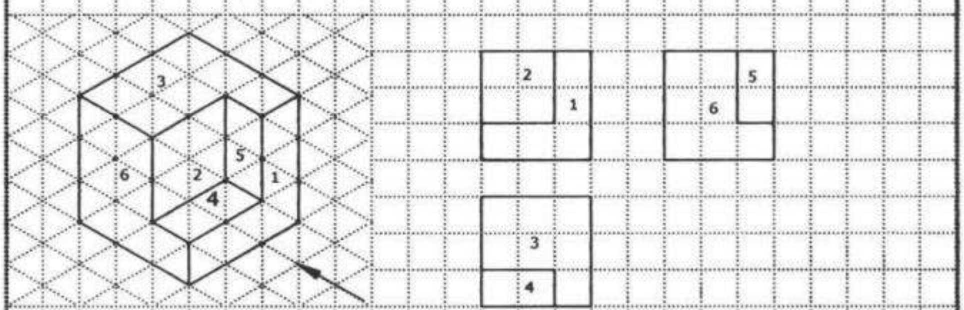


Fig.2

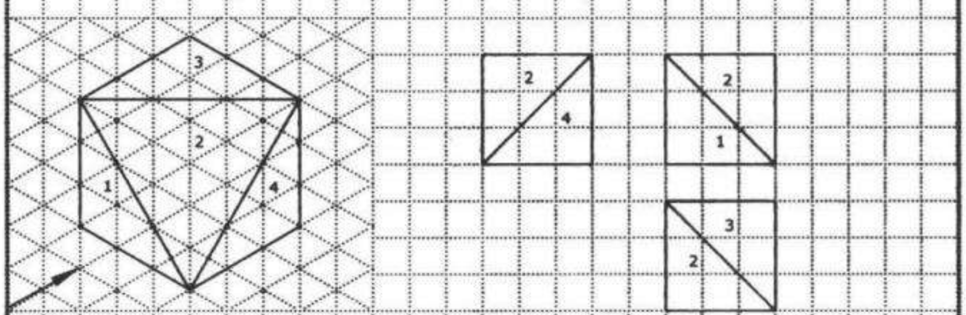
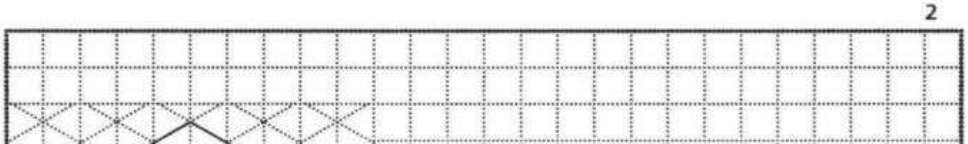


Fig.3



Objective Questions (wherever necessary explain with sketches)

1. Chapter

1.1 Writing a letter is known as ______ and making a drawing is also known as ______.

1.2. The difference in height between the lead and leg points in compass is _____ mm.

1.3. A mechanical pencil is specified by the ________ of the lead.

1.4. Pencil leads are graded by the ______ or _______ of the lead.

1.5 An enlarged scale is to represent small dimension as big. (True/False)

1.6 Normally used scale is ___________

1.7. Templates are used for ____________ features.

1.8. As per BIS standard drawing sheets vary from _____ to ________

1.9. French curves help to make a smooth curve joining the points marked. (True/False).

1.10. M2 scale is used to represent _________scale.

1.11. _______ is used in compass to draw large arcs or circles.

1.12. _______ compass is used for small circles.

1.13. ________ Mini draughter is used to make angles. (True/False)

2. Chapter

2.1 The principle involved in arriving at drawing sheet size is given by the relations ______ and ______.

2.2. For A1 size,the surface area is ________. The length is equal to ____ and width is equal to ________.

2.3. The size of the title block is __________.

2.4. The location of the title block is ___________.

2.5. The ratio of thick to thin line ticknesses is ___________.

2.6. Hidden lines are represented by ____________ lines.

2.7. A dimension with importance in the component is known as __________ dimension.

2.8. Axes line cross at small dashes. (True/False)

2.9. The thickness of the line of letters having 10mm height is _________mm.

2.10. Drawing title is written in ___________ or __________ mm size.

2.11. Hatching and sub titles are written in ______or ________mm size.

2.12. The inclination of the inclined lettering is _____________ degrees.

2.13. Lettering with adjoining stems require ______________ spacing. (More/Less)

CHAPTER 2

Lettering and Dimensioning Practices

(As per BIS : SP : 46 : 2003)

2.1 Introduction

Engineering drawings are prepared on standard size drawing sheets. The correct shape and size of the object can be visualised from the understanding of not only its views but also from the various types of lines used, dimensions, notes, scale etc. For uniformity, the drawings must be drawn as per certain standard practice. This chapter deals with the drawing practices as recommended by Bureau of Indian Standards (BIS) SP: 46:2003. These are adapted from what is followed by International Standards Organisation (ISO).

2.2 Drawing Sheet

The standard drawing sheet sizes are arrived at on the basic Principal of $x : y = 1 : \sqrt{2}$ and $xy = 1$ where x and y are the sides of the sheet. For example A0, having a surface area of 1 Sq.m; x = 841 mm and y = 1189 mm. The successive sizes are obtained by either by halving along the length or doubling the width, the area being in the ratio 1 : 2. Designation of sizes is given in Fig.2.1 and their sizes are given in Table 2.1. For class work use of A2 size drawing sheet is preferred.

Table 2.1

Designation	Dimension, mm Trimmed size
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297

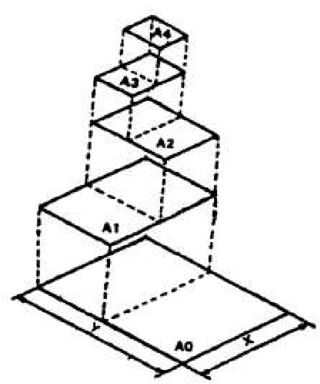


Fig. 2.1 Drawing Sheet Formats

2.2.1 Title Block

The title block should lie within the drawing space at the bottom right hand corner of the sheet. The title block can have a maximum length of 170 mm providing the following information.

1. Title of the drawing

CHAPTER 3

Scales

3.1 Introduction

It is not possible always to make drawings of an object to its actual size. If the actual linear dimensions of an object are shown in its drawing, the scale used is said to be a **full size scale.** Wherever possible, it is desirable to make drawings to full size.

3.2 Reducing and Enlarging Scales

Objects which are very big in size can not be represented in drawing to full size. In such cases the object is represented in reduced size by making use of reducing scales. Reducing scales are used to represent objects such as large machine parts, buildings, town plans etc. A reducing scale, say 1:10 means that 10 units length on the object is represented by 1 unit length on the drawing.

Similarly, for drawing small objects such as watch parts, instrument components etc., use of full scale may not be useful to represent the object clearly. In those cases enlarging scales are used. An enlarging scale, say 10:1 means one unit length on the object is represented by 10 units on the drawing.

The designation of a scale consists of the word. SCALE, followed by the indication of its ratio as follows. (Standard scales are shown in Fig. 3.1)

Scale 1:1 for full size scale

Scale 1: x for reducing scales (x = 10,20......etc.,)

Scale x:1 for enlarging scales.

Note : For all drawings the scale has to be mentioned without fail.

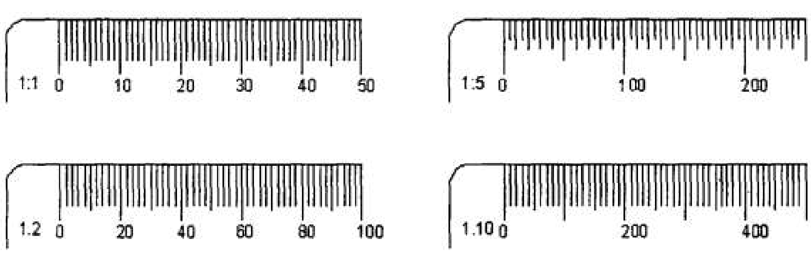


Fig. 3.1 Scales

3.3 Representative Fraction

The ratio of the dimension of the object shown on the drawing to its actual size is called the Representative Fraction (RF).

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.

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).

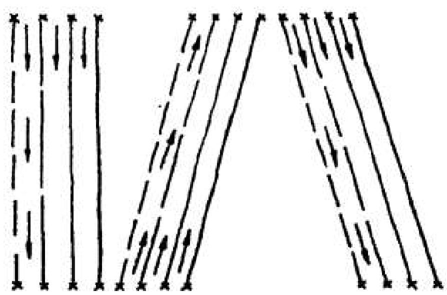


Fig. 13.1 Sketching Straight Lines

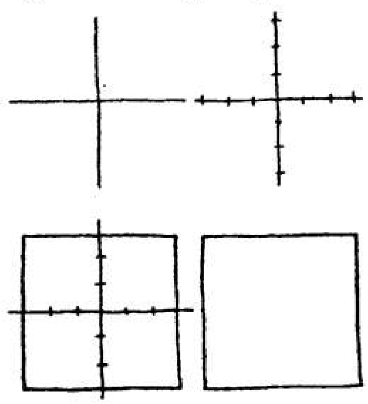


Fig. 13.2 Sketching a Square

CHAPTER 10

Oblique and Perspective Projections

10.1 Introduction

Pictorial projections are used for presenting ideas which may be easily understood by all without technical training. They show several faces of an object in one view, as it appears to the eye approximately. Among the pictorial projections, Isometric Projections are the most common as explained in previous chapter.

10.2 Oblique Projection

Oblique Projection of an object may be obtained by projecting the object with parallel projections that are oblique to the picture plane (Fig 10.1)

In oblique projection, the front face of the object appears in its true size and shape, as it is placed parallel to the picture plane. The receding lines representing the other two faces are usually drawn at 30°, 45° or 60° to the horizontal, 45° being the most common practice.

As in the case of isometric projection, in oblique projection also, all lines that are parallel on the object appear parallel on the drawing and vertical lines on the object appear vertical.

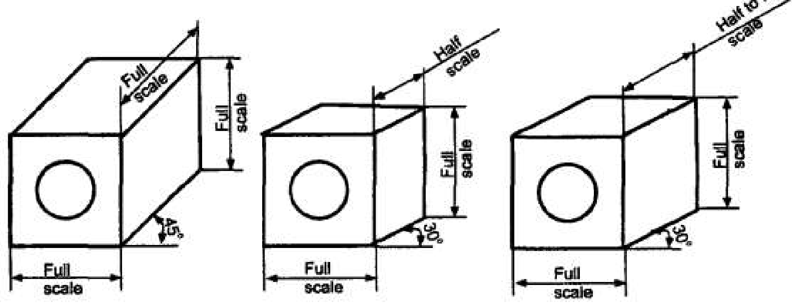


Fig. 10.1

10.3 Classification of Oblique Projection

Oblique projections are classified as cavalier, cabinet and general, depending on the scale of measurement followed along the receding lines, as shown in Fig 10.1. The oblique projection shown

CHAPTER 6

Projection of Solids

6.1 Introduction

A solid has three dimensions, the length, breadth and thickness or height. A solid may be represented by orthographic views, the nuber of which depends on the type of solid and its orientation with respect to the planes of projection. solids are classified into two major groups. (i) Polyhedra, and (ii) Solids of revolution

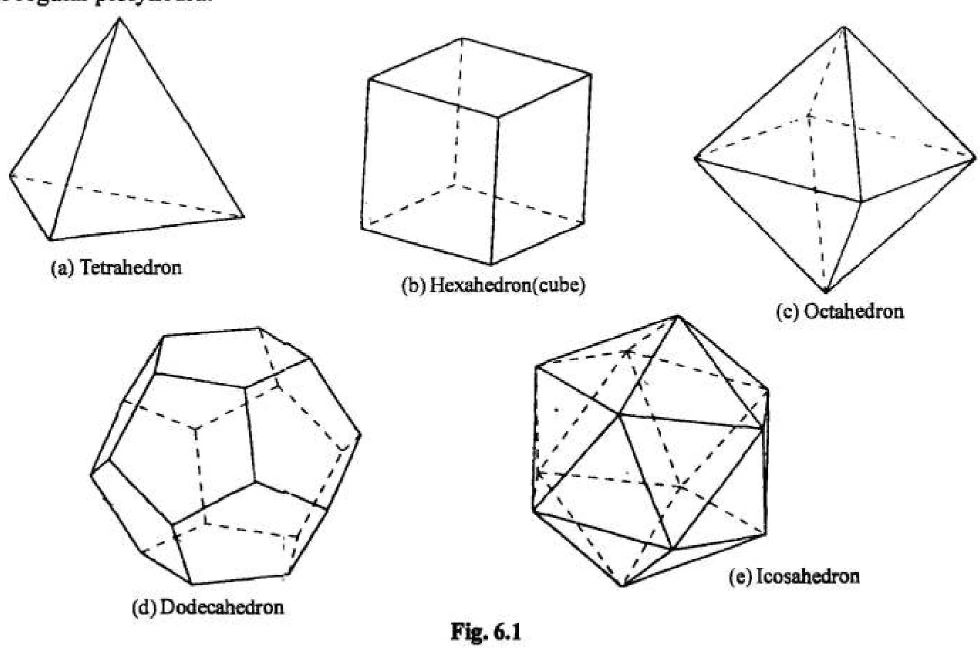
6.1.1 Polyhedra

A polyhedra is defined as a solid bounded by plane surfaces called faces. They are :

(i) Regular polyhedra (ii) Prisms and (iii) Pyramids.

6.1.2 Regular Polyhedra

A polyhedron is said to be regular if its surfaces are regular polygons. The following are some of the regular plolyhedra.



(a) Tetrahedron (b) Hexahedron(cube) (c) Octahedron (d) Dodecahedron (e) Icosahedron

Fig. 6.1

(a) Tetrahedron: It consists of four equal faces, each one being a equilateral triangle.

(b) 'Hexa hedron(cube): It consists of six equal faces, each a square.

(c) Octahedron : It thas eight equal faces, each an equilateral triangle.

CHAPTER 7

Devlopment of Surfaces

7.1 Introduction

A layout of the complete surface of a three dimentional object on a plane is called the development of the surface or flat pattern of the object. The development of surfaces is very important in the fabrication of articles made of sheet metal.

The objects such as containers, boxes, boilers, hoppers, vessels, funnels, trays etc., are made of sheet metal by using the principle of development of surfaces.

In making the development of a surface, an opening of the surface should be determined first. Every line used in making the development must represent the true length of the line (edge) on the object.

The steps to be followed for making objects, using sheet metal are given below:

1. Draw the orthographic views of the object to full size.
2. Draw the development on a sheet of paper.
3. Transfer the development to the sheet metal.
4. Cut the development from the sheet.
5. Form the shape of the object by bending.
6. Join the closing edges.

Note: In actual practice, allowances have to be given for extra material required for joints and bends. These allowances are not cosidered in the topics presented in this chapter.

7.2 Methods of Development

The method to be followed for making the development of a solid depends upon the nature of its lateral surfaces. Based on the classification of solids, the folloiwing are the methods of development.

1. Parallel-line Development

It is used for developing prisms and single curved surfaces like cylinders in which all the edges / generators of lateral surfaces are parallel to each other.

2. Radial-line Development

It is employed for pyramids and single curved surfaces like cones in which the apex is taken as centre and the slant edge or generator (which are the true lengths)as radius for its development.

7.2.1 Develop[ment of Prism

To draw the development of a square prism of side of base 30mm and height 50mm.

Construction (Fig.7.1)

CHAPTER 1

Drawing Instruments and Accessories

1.1 Introduction

Engineering drawing is a two dimensional representation of three dimensional objects. In general, it provides necessary information about the shape, size, surface quality, material, manufacturing process, etc., of the object. It is the graphic language from which a trained person can visualise objects.

Drawings prepared in one country may be utilised in any other country irrespective of the language spoken. Hence, engineering drawing is called the universal language of engineers. Any language to be communicative, should follow certain rules so that it conveys the same meaning to every one. Similarly, drawing practice must follow certain rules, if it is to serve as a means of communication. For this purpose, Bureau of Indian Standards (BIS) adapted the International Standards on code of practice for drawing. The other foreign standards are : DIN of Germany, BS of Britain and ANSI of America.

1.2 Role of Engineering Drawing

The ability to read drawing is the most important requirement of all technical people in any profession. As compared to verbal or written description, this method is brief and more clear. Some of the applications are : building drawing for civil engineers, machine drawing for mechanical engineers, circuit diagrams for electrical and electronics engineers, computer graphics for one and all.

The subject in general is designed to impart the following skills.

1. Ability to read and prepare engineering drawings.
2. Ability to make free – hand sketching of objects.
3. Power to imagine, analyse and communicate, and
4. Capacity to understand other subjects.

1.3 Drawing Instrument and Aids

The Instruments and other aids used in draughting work are listed below :

1. Drawing board
2. Mini draughter
3. Instrument box
4. Set squares
5. Protractor
6. Set of scales
7. French curves
8. Drawing sheets
9. Pencils
10. Templates

1.3.1 Drawing Board

Until recently drawing boards used are made of well seasoned softwood of about 25 mm thick with a working edge for T-square. Now a days mini-draughters are used instead of T-squares which can be fixed on any board. The standard size of board depends on the size of drawing sheet size

CHAPTER 9

Isometric Projection

9.1 Introduction

Pictorial projections are used for presenting ideas which may be easily understood by persons even with out technical training and knowledge of multi-view drawing. The Pictorial drawing shows several faces of an object in one view, approximately as it appears to the eye.

9.2 Principle of Isometric Projections

It is a pictorial orthographic projection of an object in which a transparent cube containing the object is tilted until one of the solid diagonals of the cube becomes perpendicular to the vertical plane and the three axes are equally inclined to this vertical plane.

Insometric projection of a cube in steps is shown in Fig.9.1. Here ABCDEFGH is the isometric projection of the cube.

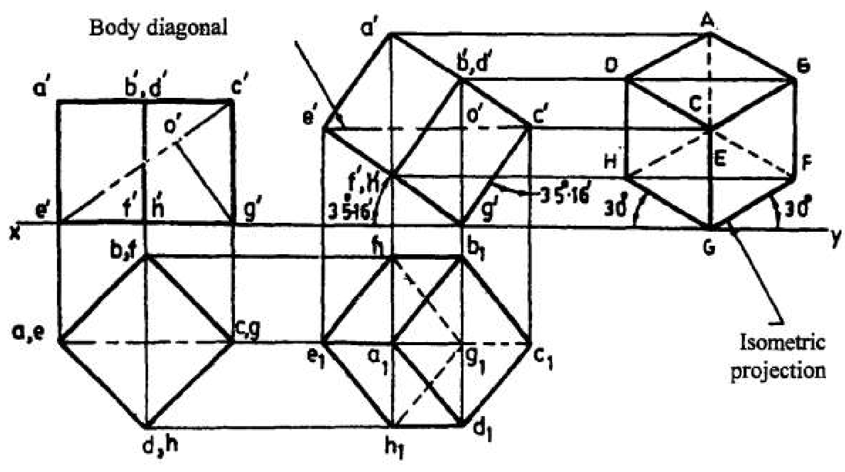


Fig. 9.1 Principle of Isometric Projection

The front view of the cube, resting on one of its corners (G) is the isometric projection of the cube. The isometric projection of the cube is reproduced in Fig.9.2.

Isometric Scale

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.

CHAPTER 4

Geometrical Constructions

4.1 Introduction

Engineering drawing consists of a number of geometrical constructions. A few methods are illustrated here without mathematical proofs.

1. **To divide a straight line into a given number of equal parts say 5. construction (Fig.4.1)**

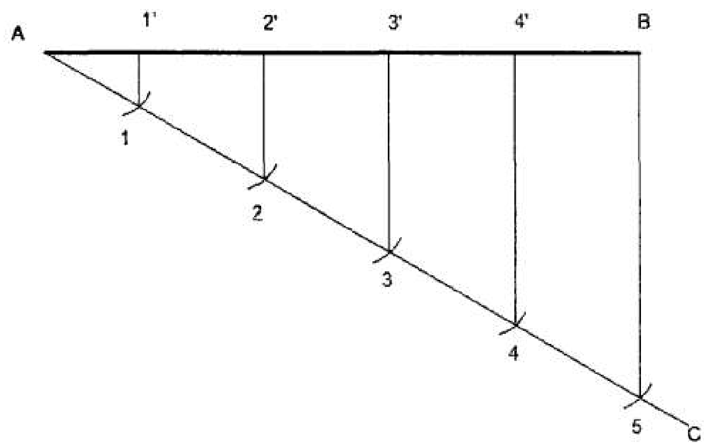


Fig. 4.1 Dividing a line

1. Draw AC at any angle θ to AB.
2. Construct the required number of equal parts of convenient length on AC like 1, 2, 3.
3. Join the last point 5 to B
4. Through 4, 3, 2, 1 draw lines parallel to 5B to intersect AB at 4', 3', 2' and 1'

2. **To divide a line in the ratio 1 : 3 : 4. construction (Fig.4.2)**

As the line is to be divided in the ratio 1:3:4 it has to be divided into 8 equal divisions. By following the previous example divide AC into 8 equal parts and obtain P and Q to divide the line AB in the ratio 1:3:4.

CHAPTER 5

Orthographic Projections

5.1 Introduction

In the preceding chapters 1 to 4 **plane geometry,** where the constructions of the geometrical figures having only two dimensions are discussed, **solid geometry** is delt with in the following chapters.

Engineering drawing, particularly solid geometry is the graphic language used in the industry to record the ideas and informations necessary in the form of blue prints to make machines, buildings, strutures etc., by engineers and technicians who design, develop, manufacture and market the products.

5.1.1 Projection

As per the optical physics, an object is seen when the light rays called visual rays coming from the object strike the observer's eye. The size of the image formed in the retina depends on the distance of the observer from the object.

If an imaginary transparent plane is introduced such that the object is in between the observer and the plane, the image obtained on the screen is as shown in Fig.5.1. This is called **perspective view** of the object. Here, straight lines (rays) are drawn from various points on the contour of the object to meet the transparent plane, thus the object is said to be **projected** on that plane.

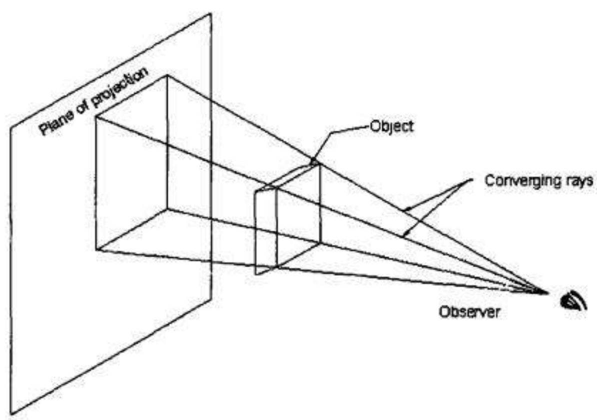


Fig. 5.1 Perspective Projection

The figure or view formed by joining, in correct sequence, the points at which these lines meet the plane is called the projection of the object. The lines or rays drawn from the object to the plane are called projectors. The transparent plane on which the projections are drawn is known as plane of projection.

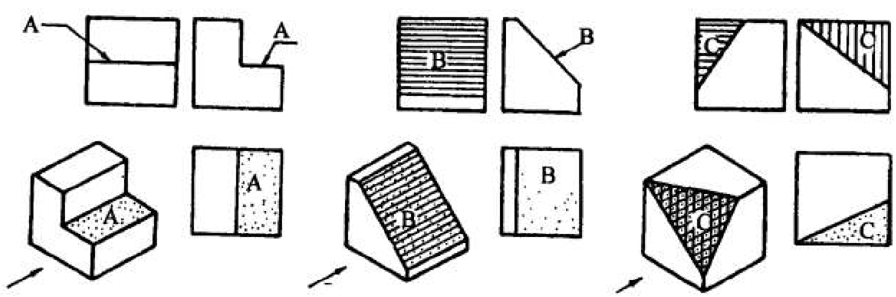
CHAPTER 11

Conversion of Isometric Views to Orthographic Views and Vice Versa

11.1 Introduction

The following principles of orthographic views are considered in making the above drawings :

1. In first angle projection; the **Front view** on the above and the **Top view** at the bottom are always in line vertically.
2. The **front view** and the **side view** are always in line horizontally.
3. Each view gives two dimensions; usually the front view gives lengh and height, top view gives length and width and side view gives hight and width.
4. When the surface is parallel to a plane its projection on that plane will show its true shape and size.
5. When the surface is inclined its projection will be foreshortened as shown.(Fig.11.1)



(a) - True Shaped Surface - A　　(b) - Foreshortened Surface - B　　(c) - Oblique Surface - C

Fig. 11.1 Representation of Surfaces

11.2 Selection of views

1. The number of orgthographic views required for clear description of the object is taken as the criteria to select the views. As far as possible least number of views are drawn.

2. While selecting the views; the object is placed in such a way the number of hidden lines are kept to minimum.
3. Front view is drawn seeing the object in a direction is which its length is seen. It is also chosen such that the shape of the object is revealed. The direction of the view is indicated

CHAPTER 8

Intersection of Surfaces

8.1 Introduction

Ducts, pipe joints, smoke stacks, boilers, containers, machine castings etc., involve intersection of surfaces. Sheetmetal work required for the fabrication of the above objects necessiate the preparation of the development of the joints/ objects. Orthographic drawings of lines and curves of intersection of surfaces must be prepared first for the accurate development of objects. Methods of obtaining the lines and curves of intersection of surfaces of cylinder and cylinder, prism and prism are shown to introduce the subject. Figure 8.1 Shows intersection of two cylinders.

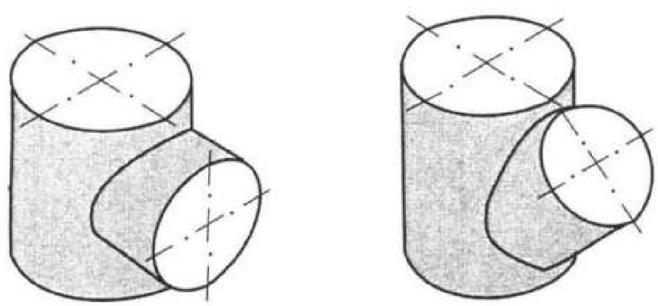


Fig. 8.1

8.2 Intersection of cylinder and cylinder

Example 1: *A horizontal cylinder of diameter 40 mm penetrates into a vertical cylinder of diameter 60 mm. The axes of the cylinders intersect at right angles. Draw the curves of intersection when the axis of the horizontal cylinder is parallel to the VP.*

Solution : (Fig 8.2)

1. Draw the top and front views of the cylinders.
2. Draw the left side view of the arrangement.
3. Divide the circle in the side view into number of equal parts say 12.

4. The generators of the horizontal cylinder are numbered in both front and top views as shown.
5. Mark point m, where the generator through 1 in the top view meets the circle in the top view of the vertical cylinder. Similarly mark $m_2, \ldots\ldots\ldots m_{12}$.
6. Project m^1_7 to m^1_1 on the generator $1^1\ 1^1$ in the front view.

ANSWERS

1. Chapter

1.1 drafting / draughting. 1.2. 1mm, 1.3. daiameter,
1.4. Hárdness, Softness 1.5. True, 1.6. Full scale
1.7. Standard (circles,etc.,) 1.8. A0 to A4 1.9. True.
1.10. 1:5 1.11. Lengthening bar 1.12. Bow
1.13. True.

2. Chapter

2.1 X:Y = 1: $\sqrt{2}$, XY =1 2.2. 594 x 841, 841, 594 2.3. 170 x 65
2.4 at RH corner 2.5. 2:1 2.6. Thin dotted lines
2.7. Functional 2.8. F 2.9. 1mm
2.10. 7 or 10 mm 2.11. 3.5 or 10mm 2.12. 15^0
2.13. more 2.14. True 2.15. True
2.16. True 2.17. True. 2.18. False
2.19. False 2.20. 3:1 2.21. True
2.22. True 2.23. True 2.24. not broken
2.25 False 2.26. True 2.27. True
2.28. (a) Aligned and (b) unidrectional.

3. Chapter

3.1 Representative Factor also known as Scale Factor.
3.2. False 3.3. Greater than 1:1 3.4.Enlarging
3.5. Diagonal 3.11. True 3.12. True
3.13. False.

4 Chapter

4.4. Conic 4.5. (a) Ellipse, (b) Parabola, (c) Hyperbola, (d) Cicle.
4.6. Isosceles triangle, 4.7. 90^0 4.8. True, 4.9. Hyperbola
4.14. Cycloids. 4.15. False. 4.16 Epi-Cycloid.
4.17. Involute. 4.18. Involute.

5. Chapter

5.1. First and Third angle 5.3 Projectors, plane. 5.4 First angle
5.5 Third angle 5.6 True 5.7. False.
5.8. Parallel 5.9. Vertical, Normal 5.10. Horizontal, top.
5.11, (a)Below (b) Left 5.12. (a) above, (b) right 5.13. Profitle plane, normal, side

5.14. True. 5.15. Locus 5.16. Front
5.17. HP 5.18. True 5.19. (b) Front view
5.20 (a) XY 5.21. Fourth 5.22. True.
5.23. Above 5.24. Behind 5.25. On HP and VP.