	AGRICULTURAL TVET COLLEGE	

SMALL SCALE IRRIGATION DEVELOPMENT LEVEL-II

MODEL TTLM

Learning Guide #17

Unit of competency: Develop Reading Technical Drawing

Module Title: Reading Technical Drawing

LG code: AGR SSI1M 17 LO1-LO5

TTLM Code: AGR SSI1 TTLM 1218V1

Nominal Duration: 40 Hours

Instruction sheet	Learning guide #17

This learning guide is developed to provide you the necessary information regarding the following learning out comes, content coverage and topics:

- Identify and select drawing instruments
- Sketch and lettering
- Understand Geometry of technical drawing
- Overview of Multi view drawing and Sectioning
- Determine Axonometric projection drawing

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Identify and select drawing instruments
- Select tables and straight edges
- Make available drawing table and measuring tools
- Identify manual and automated drawing tools
- Sketch lines and angles.
- Sketch circular/elliptical objects.
- Graduation measuring devices.
- Sketch letters.
- Sketch points and lines roughly.
- Sketch angles, quadrilaterals and polygons
- Sketch circles and arcs.
- Sketch bisecting and dividing.
- Sketch perpendiculars and tangents.
- Identify line types appropriately.
- Identify orientation of views.
- Sketch the auxiliary views.
- Dimension multi view drawing.
- Sketch full section
- Assess isometric projections.

- Assess di-metric projection.
- Assess trimetric projection.

Learning Activities:-

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the "Information Sheets"
3. Accomplish the "Self-checks"
4. If you earned a satisfactory evaluation proceed to "the next information sheet However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
5. Submit your accomplished Self-check. This will form part of your training portfolio (if necessary).

Information sheet 1	**Identify and select drawing instruments**

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 visualize objects.

Drawings prepared in one country may be utilized 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 everyone. 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.

1.1 Selecting tables and straight edges

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 clearer. 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.

- Ability to read and prepare engineering drawings.
- Ability to make free - hand sketching of objects.
- Power to imagine, analyses and communicate, and
- Capacity to understand other subjects

1.2 Making available drawing Table and measuring tools

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

1.2.1 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. Nowadays 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 required.

Fig. 1.1 Drawing board

1.2.2 Mini-Draughter

Mini-draughter consists of an angle formed by two arms with scales marked and rigidly hinged to each other. It combines the functions of T-square, set-squares, scales and protractor. It is used for drawing horizontal, vertical and inclined lines, parallel and perpendicular lines and for measuring lines and angles.

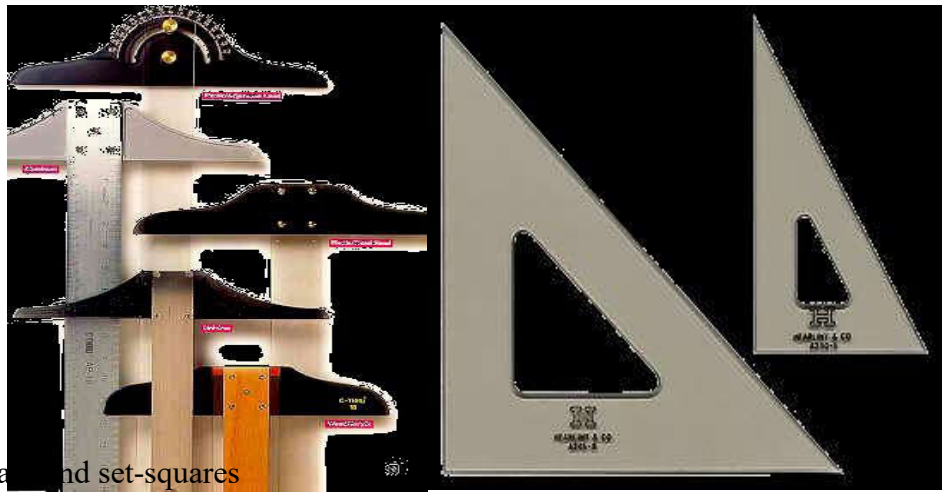


Fig: 1.2 T-squa nd set-squares

1.2.3 Instrument Box

Instrument box contains

- Compasses,
- Dividers and
- Inking pens.

What is important is the position of the pencil lead with respect to the tip of the compass. It should be at least I mm above as shown in Fig. 1.2 because the tip goes into the board for grip by 1 mm.

Fig. 1.3 Compass

1.2.4 Set of Scales

Scales are used to make drawing of the objects to proportionate size desired. These are made of wood, steel or plastic. BIS recommends eight set-scales in plastic/cardboard with designations MI, M2 and so on.

1.2.5 French Curves

French curves are available in different shapes (Fig. 1.4). First a series of points are plotted along the desired path and then the most suitable curve is made along the edge of the curve. A flexible curve consists of a lead bar inside rubber which bends conveniently to draw a smooth curve through any set of points.

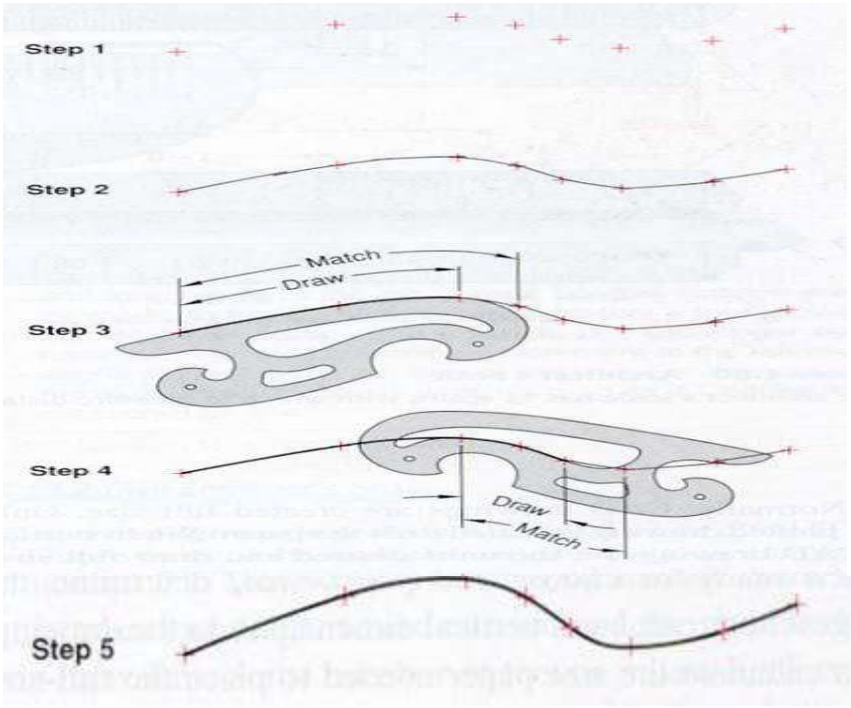


Fig:-1.4 French curves

1.2.6 Templates

These are aids used for drawing small features such as circles, arcs, triangular, square and other shapes and symbols used in various science and engineering fields (Fig.l.5).

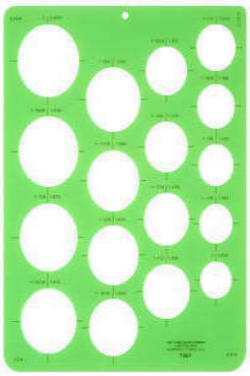


Fig. 1.5 Circle templates

1.2.7 Pencils

Pencils with leads of different degrees of hardness or grades are available in the market. The hardness or softness of the lead is indicated by 3H, 2H, H, HB, B, 2B, 3B, etc. The grade HB denotes medium hardness of lead used for general purpose. The hardness increases as the value of the numeral before the letter H increases. The lead becomes softer, as the value of the numeral before B increases. The selection of the grade depends on the line quality desired for the drawing. Pencils of grades H or 2H may be used for finishing a pencil drawing as these give a sharp black line. Softer grade pencils are used for sketching work. HB grade is recommended for lettering and dimensioning. Nowadays mechanical pencils are widely used in place of wooden pencils. When these are used, much of the sharpening time can be saved. The number 0.5, 0.70 of the pen indicates the thickness of the line obtained with the lead and the size of the lead diameter. Micro-tip pencils with 0.5 mm thick leads with the following grades are recommended. HB Soft grade for Border lines, lettering and free sketching H Medium grade for visible outlines, visible edges and boundary lines 2H Hard grade for construction lines, Dimension lines, Leader lines, Extension lines, Centre lines, Hatching lines and Hidden lines.

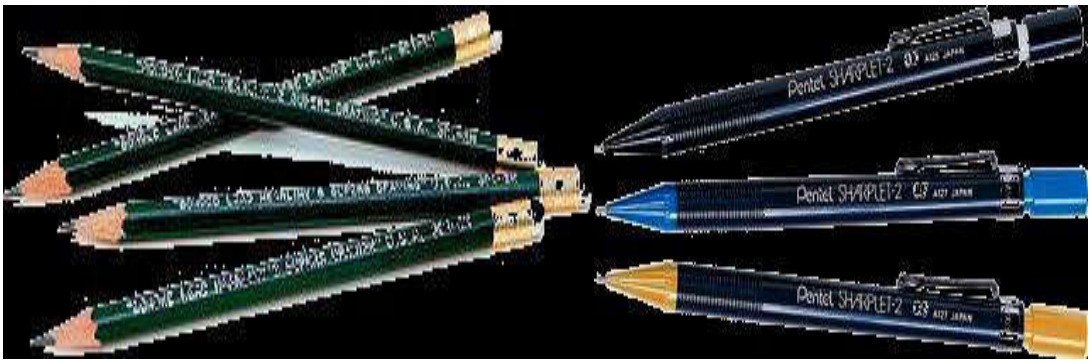


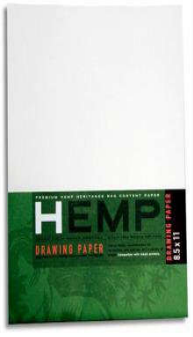
Fig. 1.6 leads and mechanical pencils

1.2.8 Other drawing tools

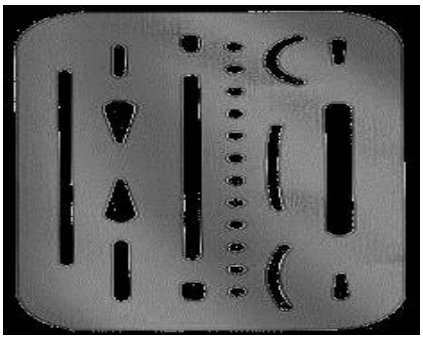

Adhesive Tape


Sandpaper

Pencil Eraser



Clean paper


Erasing Shield


Tissue paper

Sharpener

Fig. 1.7 Other drawing tools

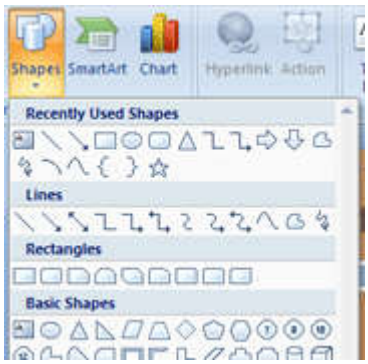
1.3 Manual and Automated drawing tools (AutoCAD.)

There are many different types of manual and automated drawing tools are available but it is not

recommended to use the complicated automated drawing tools in this level because of its scope and resources limitations. This drawing tools my function the following tasks like:

- Detail drawings may be created more quickly and making changes is more efficient than correcting drawings drawn manually.
- It allows different views of the same object and 3D pictorial view, which gives better visualization of drawings
- Designs and symbols can be stored for easy recall and reuse.
- By using the computer, the drawing can be produced with more accuracy.
- Drawings can be more conveniently filed, retrieved and transmitted on disks and tape.
- Quick design analysis, also simulation and testing possible.

Drawing Preset Shapes



In the Insert command tab, the Shapes group contains several categories of shapes, including lines, basic shapes, block arrows, flowchart elements, stars and banners, and callouts.

- To see PowerPoint's built-in shapes, go to the Insert tab and under the Illustrations group click on the Shapes button to see the list.
- Click on your desired shape.
- On the slide, click and drag your mouse to create your shape.
- Once your shape is in place you can move it around, use the handles to change the size and rotation, and edit it as you would any other object.

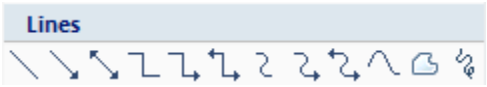
Drawing Custom Shapes

To draw your own shapes you can use the freehand drawing tools, *Curve, Freeform* and *Scribble*. *Curve* lets you draw shapes with curves; *Freeform* lets you draw shapes with both curves and angles; and *Scribble* lets you draw shapes and lines freehand. You can also combine these tools with other preset shapes (see Editing Images for instructions on grouping objects).

From the Insert tab in the Illustrations group click on the Shapes button.

Under Lines, the last three (3) options are Curve, Freeform and Scribble.

Note: You can use the other options to create shapes as well, however these three are the only ones we will cover in this tutorial.



To create a Curve

Click and release your mouse button on the slide to begin the shape.

Drag your mouse to draw. Click to anchor a point around which your curve will form.

To finish your drawing, either double-clicks to leave it as a line, or link the curve by clicking the starting point to create a solid shape.

- To create a freeform shape
- Click and release your mouse button to begin the shape.
- To anchor the endpoints of straight lines, click and release.
- To draw curves, click and drag.

Hint: The Freeform tool allows you to draw both straight and curved lines in the same picture.

To finish your drawing, either double-click to leave it as a line, or click the starting point to create a solid shape.

To create a Scribble

Click and drag your mouse to draw a Scribble.

Double-click when you are finished drawing or click the starting point to create a solid shape.

Adding Text to a Shape

Rather than going through the hassle of layering text boxes on top of shapes, you can add text directly to a shape so that it moves, rotates, shrinks and expands when you format the object.

First click on the shape to select it.

Under the Drawing Tools - Format tab in the Shapes group click on Text Box.

Your mouse cursor will change into a text cursor. Click inside the shape and start typing. Your text will automatically be aligned to the center of the image.

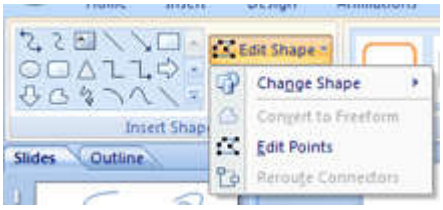
Whenever you move your mouse over the text area of the shape your pointer will change to the text cursor to allow you to select and edit your text. Highlight the text and use the options on the Home tab to edit it, or use the WordArt features under the Drawing Tools tab to add 3D effects (see Formatting Text)

Editing Custom Shapes

Drawings in PowerPoint can be formatted just like any other object - you can move them, use the handles to resize and rotate (see the instructions for resizing and formatting text boxes).

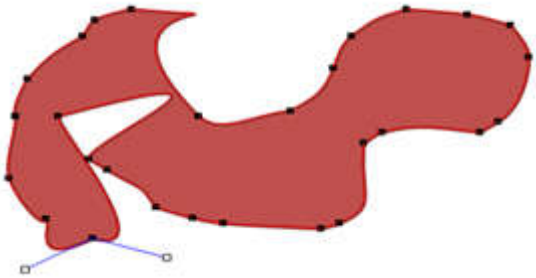
Anchors

With custom shapes you have the additional ability to edit anchor points, the key to making sure your drawing is just the way you want.



Double-click on your drawing to activate the Drawing Tools - Format tab. In the Insert Shape group, click on the Edit Shape button and choose Edit Points.

Black points will appear around your shape. You can either click on a point and drag it to stretch or shrink that area of your shape, or you can click on a point and use the line and handles that appear to alter the curve (as in the bottom left of the shape below).



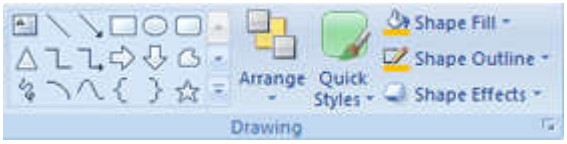
Note: More points will appear for a freehand or scribble shape than for a curve as these have more rough points. To create a new point click and drag anywhere on the edge of your shape.

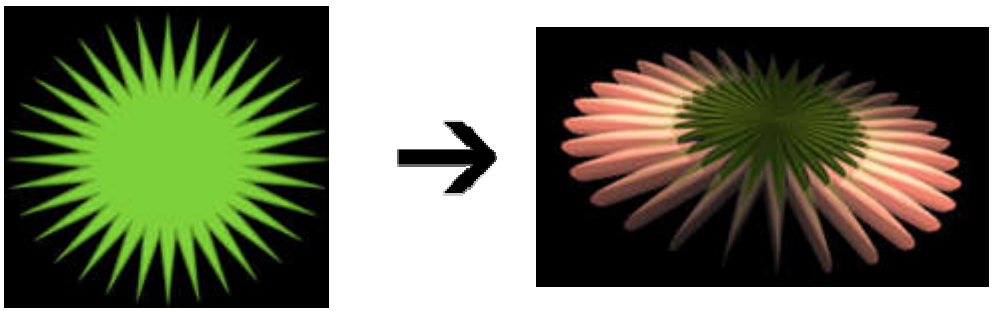
Shape Styles

You can also change the color and outline of a shape, or add 3D effects. You can reach these options either by double-clicking the shape and using the Drawing Tools tab or by using the more condensed Drawing group in the Home tab.

The Shape Styles group on the Drawing Tools tab provides the tools to customize your shape. Choose a preset style from the Style Gallery, or create your own by using the Shape Fill and Shape Outline menus to pick the color of your shape and border and the Shape Effects menu to add shadow, bevel, and other 3D effects

The Drawing group on the Home tab has all the options of the Shape Styles group as well as the Shape gallery and the Arrange menu. To access the Shape Style gallery click on the Quick Styles button.





Use 3D effects to make more interesting shapes! (3D Preset 10 with Warm Sunset lighting)

Self-Check 1	**Written Test**

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. How can we select appropriate drawing tools, explain the ways how we uses them? (10pts)
2. What are manual and automated drawing tools, how can we use them?(8pts)

Note: Satisfactory rating – 9 points and above Unsatisfactory - below 9 points you can ask you teacher for the copy of the correct answers.

Information sheet-2	Sketching and Lettering

2.1 Sketching lines and angles using standard technique.

Straight Line

- Hold the pencil naturally.
- Spot the beginning and end points.
- Swing the pencil back and forth between the points, barely touching the paper until the direction is clearly established.
- Draw the line firmly with a free and easy wrist-and-arm motion

2.2 Sketching circular/elliptical objects using standard technique.

Circle

Method 1: Starting with a square

- Lightly sketching the square and marking the mid-points.
- Draw light diagonals and mark the estimated radius.
- Draw the circle through the eight points.

Method 2: Starting with center line

- Lightly draw a center line.
- Add light radial lines and mark the estimated radius.
- Sketch the full circle.

2.3 Graduating measuring devices

Technical drawing tools include and are not limited to: pens, rulers, compasses, protractors and drawing utilities. Drafting tools may be used for measurement and layout of drawings, or to improve the consistency and speed of creation of standard drawing elements. The tools used for manual technical drawing have been displaced by the advent of the personal computer and its common utilization as the main tool in computer-aided drawing, draughting and design

Pencil: Traditional and typical styli used for technical drawing are pencils and technical pens.

Pencils in use are usually mechanical pencils with a standard lead thickness. The usual line widths are 0.18 mm, 0.25 mm, 0.5 mm and 0.7 mm. Hardness varies usually from HB to 2H. Softer lead gives a better

contrast, but harder lead gives a more accurate line. Bad contrast of the lead line in general is problematic when photocopying, but new scanning copy techniques have improved the final result. Paper or plastic surfaces require their own lead types.

Drafting board: The drawing board is an essential tool. Paper will be attached and kept straight and still, so that the drawing can be done with accuracy. Generally, different kind of assistance rulers is used in drawing. The drawing board is usually mounted to a floor pedestal in which the board turns to a different position, and also its height can be adjustable. Smaller drawing boards are produced for table-top use.

T-square: A T-square is a straightedge which uses the edge of the drawing board as a support. It is used with the drafting board to draw horizontal lines and to align other drawing instruments. Wooden, metal, or plastic triangles with 30° and 60° angles or with two 45° angles are used to speed drawing of lines at these commonly used angles. A continuously adjustable 0–90° protractor is also in use. An alternative to the T-square is the parallel bar which is permanently attached to the drawing board. It has a set of cables and pulleys to allow it to be positioned anywhere on the drawing surface while still remaining parallel to the bottom of the board. The drafting machine replaces the T-square and triangles.

Drafting machine: A drafting machine is a device which is mounted to the drawing board. It has rulers whose angles can be precisely adjusted with a controlling mechanism. [6] There are two main types of apparatus: an arm-type parallelogram apparatus based on a hinged arm; and a track-type apparatus which moves on a rail mounted to the top of the drawing board. The accuracy of the arm type apparatus is better in the middle of the board, decreasing towards the edges, whereas a track machine has a constant accuracy over the whole board. The drawing head of a track-type drafting machine slides on bearings in a vertical rail, which in turn is moved along a horizontal, top-mounted rail. Both apparatus types have an adjustable drawing-head with rules attached to a protractor scale so that the angle of the rules may be adjusted**.**

A drafting machine allows easy drawing of parallel lines over the paper. The adjustable angle between the rulers allows the lines to be drawn in varying accurate angles. Rulers may also be used as a support for separate special rulers and letter templates. The rules are replaceable and they can be for example scale-rules.

Drawing apparatus has evolved from a drawing board mounted parallel ruler and a pantograph, which is a device used for copying objects in an adjustable ratio of sizes.

French Curves: French curves are made of wood, plastic or celluloid. Some set squares also have these curves cut in the middle. French curves are used for drawing curves which cannot be drawn with compasses. A faint freehand curve is first drawn through the known points; the longest possible curve that coincides exactly with the freehand curve is then found out from the French curves. Finally, a neat continuous curve is drawn with the aid of the French curves.[8]

Rulers: Rulers used in technical drawing are usually made of polystyrene.It is used for drawing lines and connecting points. Rulers come in two types according to the design of their edge. A ruler with a straight edge can be used with lead pencils and felt pens, whereas when a technical pen is used the edge must be grooved to prevent the spread of the ink.

A scale ruler is a scaled, three-edged ruler which has six different scales marked to its sides. A typical combination for building details is 1:20, 1:50, 1:100, 1:25, 1:75 and 1:125. There are separate rulers for zoning work as well as for inch units. Today scale rulers are made of plastic, formerly they were made of hardwood. A pocket-sized version is also available, with scales printed on flexible plastic strips.

Compass: Compasses are used for drawing circles or arc segments of circles. One form has two straight legs joined by a hinge; one leg has a sharp pivot point and the other has a holder for a technical pen or pencil. Another form, the beam compass, has the pivot point and pen holder joined by a trammel bar, useful when drawing very large radius arcs. Often a circle template is used instead of a compass when predefined circle sizes are required.

Templates: Templates contain pre-dimensioned holes in the right scale to accurately draw a symbol or sign .Letter templates are used for drawing text, including digits and letter characters. Diagrams are usually of a standard letter shape and size to conform to standards of encodings (e.g. DIN or ANSI). For example, in Finland the series used is 1.8 mm, 2.5 mm, 3.5 mm, 5.0 mm and 7.0 mm. Except for the very biggest ones, the templates are only suitable for technical pen drawing.

For drawing circles and circle-arcs, circle templates which contain a set of suitably-sized holes are used. Templates are also available for other geometric shapes such as squares and for drawing ellipses, as well as many specialized varieties for other purposes.

2.4 Sketching letters using standard technique

Lettering is defined as writing of titles, sub-titles, dimensions, etc., on a drawing.

2.4.1 Importance of Lettering

To undertake production work of an engineering component as per the drawing, the size and other details are indicated on the drawing. This is done in the form of notes and dimensions.

Main Features of Lettering: are legibility, uniformity and rapidity of execution. Use of drawing instruments for lettering consumes more time. Lettering should be done freehand with speed. Practice accompanied by continuous efforts would improve the lettering skill and style. Poor lettering mars the appearance of an otherwise good drawing.

2.4.2 Single Stroke Letters

The word single-stroke should not be taken to mean that the lettering should be made in one stroke without lifting the pencil. It means that the thickness of the letter should be uniform as if it is obtained in one stroke of the pencil.

2.4.3 Types of Single Stroke Letters

1. Lettering Type A: (I) Vertical and (ii) Sloped (at 75^0 to the horizontal)
2. Lettering Type B: (I) Vertical and (ii) Sloped (at 75^0 to the horizontal)

Type B Preferred

In Type A, height of the capital letter is divided into 14 equal parts, while in Type B; height of the capital letter is divided into 10 equal parts. Type B is preferred for easy and fast execution, because of the division of height into 10 equal parts.

Vertical Letters Preferred

Vertical letters are preferred for easy and fast execution, instead of sloped letters.

Note: Lettering in drawing should be in CAPITALS (i.e., Upper-case letters).

Lower-case (small) letters are used for abbreviations like mm, cm, etc.

2.4.4 Size of Letters

- ✓ Size of Letters is measured by the height h of the CAPITAL letters as well as numerals.
- ✓ Standard heights for CAPITAL letters and numerals recommended by BIS are given below : 1.8, 2.5, 3.5, 5, 6, 10, 14 and 20 mm

Note: Size of the letters may be selected based upon the size of drawing.

2.4.5 Procedure for Lettering

- Thin horizontal guide lines are drawn first at a distance 'h' apart.
- Lettering Technique: Horizontal lines of the letters are drawn from left to right. Vertical ,inclined and curved lines are drawn from top to bottom.
- After lettering has been completed, the guidelines are not erased.

2.4.6 Dimensioning of Type B Letters

BIS denotes the characteristics of lettering as :

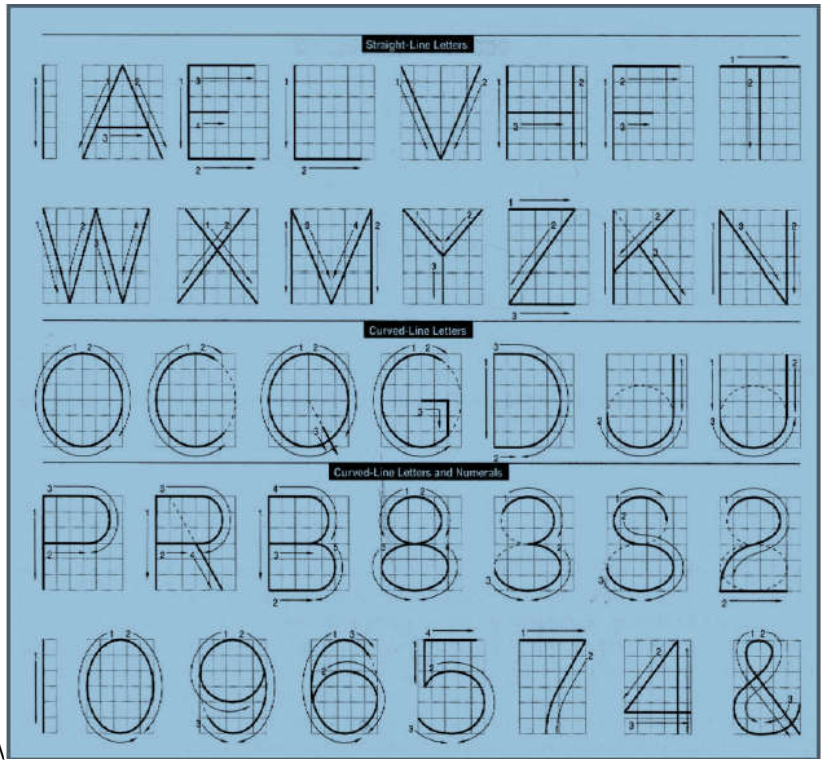
- h (height of capita) letters),
- c_1(height of lower-case letters),
- c_2 (tail of lower-case letters),
- c_3 (stem of lower-case letters),
- a (spacing between characters),
- b_1& b_2(spacing between baselines),
- e (spacing between words) and d (line thickness),

Table 2.1 Lettering Proportions

Letters / Recommended Size (height h) of Numerals	
Main Title	5 mm, 7 mm, 10 mm
Sub-Titles	3.5 mm, 5 mm
Dimensions, Notes, etc.	2.5 mm, 3.5 mm, 5 mm

2.4.7 Lettering practice

Practice of lettering capital and lower case letters and numerals of type B are shown in Figs.2.1.



Straight line letters

Curved line letters &

Numerals

\\

Fig. 2.1 Lettering

The following are some of the guide lines for lettering

Drawing numbers, title block and letters denoting cutting planes, sections are written in 10 mm size.

1. Drawing title is written in 7 mm size.
2. Hatching, sub-titles, materials, dimensions, notes, etc., are written in 3.5 mm size.
3. Space between lines = 3/4 h.
4. Space between words may be equal to the width of alphabet M or 3/5 h.
5. Space between letters should be approximately equal to 1/5 h. Poor spacing will affect the visual effect.
6. The spacing between two characters may be reduced by half if th is gives a better visual effect, as for example LA, TV; over lapped in case of say LT, TA etc, and the space is increased for letters with adjoining stems.

CAPITAL Letters

- Ratio of height to width for most of the CAPITAL letters is approximately = 10:6
- However, for M and W, the ratio = 10:8 for I the ratio = 10:2

Lower-case Letters

Height of lower-case letters with stem / tail (b, d, f, g, h, j, k, I, p, q, t, y) = $C_2 = C_3 = h$

- Ratio of height to width for lower-case letters with stem or tail = 10:5
- Height of lower-case letters without stem or tail $C_1$is approximately = (7/10) h
- Ratio of height to width for most lower-case letters without stem or tail = 7: 5
- However, for m and w, the ratio = 7: 7. For I and I, the ratio = 10:2

Numerals

- For numerals 0 to 9, the ratio of height to width = 10 : 5. For I, ratio = 10 : 2

Spacing

- Spacing between characters = a = (2/10)h
- Spacing between words = e = (6/10)h

Self-Check 1	**Written Test**

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Alphabets (upper-case & lower-case) and numerals 0 to 9 (h = 5 and 7 mm)? (5pt)

2. Practice makes a person perfect (h = 3.5 and 5)? (5pt)

3. Be a leader not a follower (h = 5)? (5pt)

4. Lettering should be done freehand with speed (h = 5)? (5pt)

Note: Satisfactory rating - 10 points and above Unsatisfactory - below 10 points

You can ask you teacher for the copy of the correct answers.

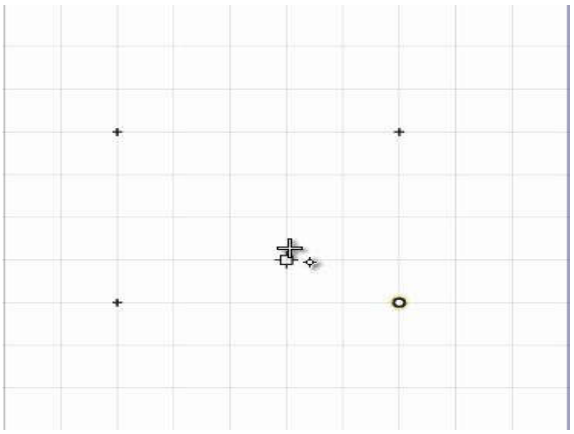
Information sheet-3	**Understanding Geometry of technical drawing**

3.1 Sketching Points and lines roughly.

1. To divide a straight line into a given number of equal parts say 5.

Construction

To sketch points:



1. Select the **Points** tool on the **Points/Lines** icon.

2. If no sketch plane is active, click on the face of a part to activate one.

3. If you want the sketch you're about to create to be a new part, click  **New Part**.

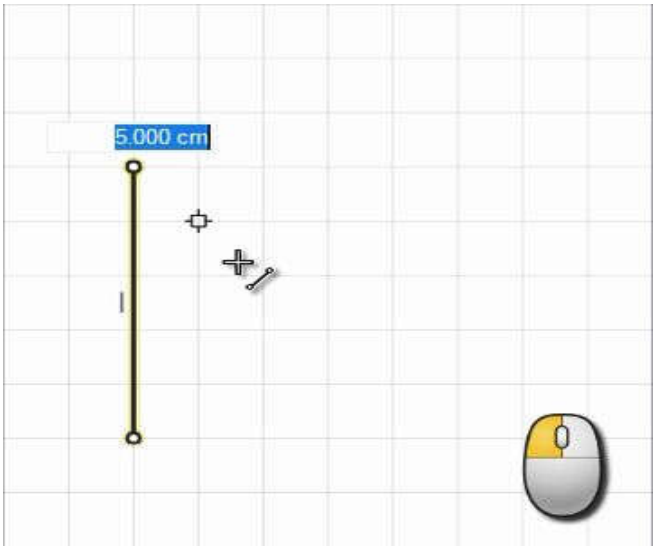
4. Click on the sketch plane to place the point. Keep clicking to create multiple points.

   Right-click to enter editing mode. The cursor turns into a white arrowhead, indicating that you can now

5. select and drag the points to reposition them.

6. Right-click to exit editing mode and again to exit push/pull mode.

To sketch lines:



1. Select the **Line** tool on the **Points/Lines** icon.

2.If no sketch plane is active, click on the face of a part to activate one.

3. If you want the sketch you're about to create to be a new part, click  **New Part**.

4. Click on the sketch plane to place the first end point of the line, and again to place the second.

Right-click to enter editing mode. The cursor turns into a white arrowhead, indicating that you can now

5. select and drag the lines to reposition them.

To change the length of the line, click near the end you want to shorten or extend, then enter a value in the

6. text box and press **Enter**.

7. Right-click to exit editing mode and again to exit push/pull mode.

3.2 Sketching angles, quadrilaterals and polygons using standard technique.

3.2.1 Polygons

Definitions

A polygon is a plane figure bounded by more than four straight sides. Polygons are

Frequently referred to have particular names some of these are listed below.

- A pentagon is a plane figure bounded by five sides
- A hexagon is a plane figure bounded by six sides

- A heptagon is a plane figure bounded by seven sides
- An octagon is a plane figure bounded by eight sides
- A nonagon is a plane figure bounded by nine sides
- A decagon is a plane figure bounded by ten sides.
- A regular polygon is one that has all its sides equal and therefore all its exterior angles equal and all its interior angles equal.
- The diameter of that circle is called the diameter of the polygon.
- The diagonal of a polygon is the distance from one corner to the corner furthest away from it.

To construct a regular octagon given the diagonal, i.e. within a given circle

Steps

- Draw the circle and insert a diameter AE.
- Construct another diagonal CG, perpendicular to the first diagonal.
- Bisect the four quadrants thus produced to cut the circle in B, D, F, and HABCDEFGH is the required octagon

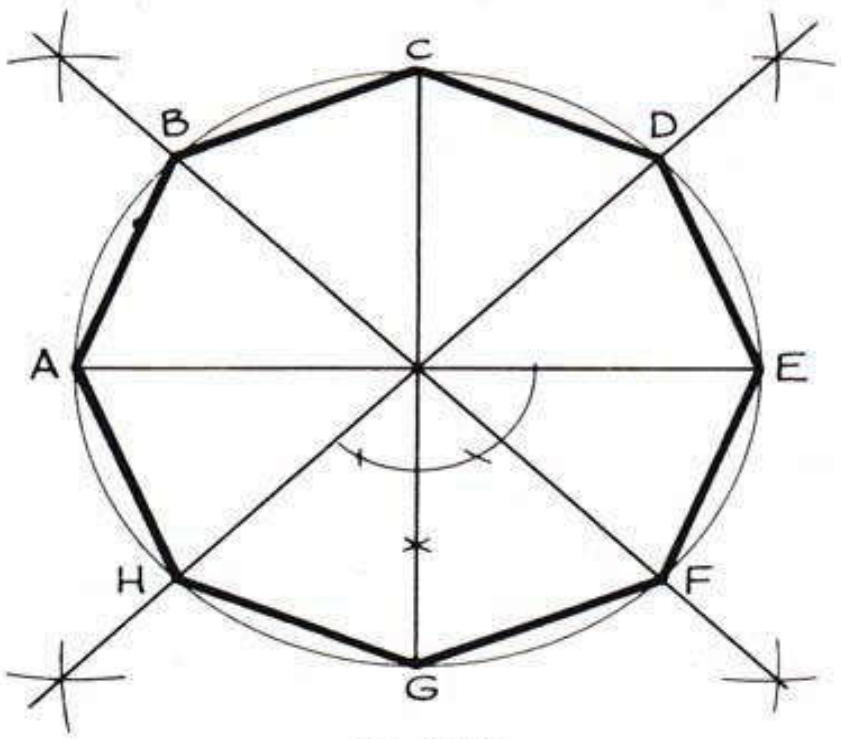


Fig. 2/29

Fig: - 3.1 regular octagon

To construct a rectangular octagon; given the diameter, i.e., within a given Square.

- Construct a square PQSR, length of side equal to the diameter.
- Draw the diagonals SQ and PR to intersect in T.
- With Centre's P, Q, R, and S draw four arcs, radius PT (=QT = RT=ST) to cut the square in A, B, C, D, E, F, G and HABCDEFGH is the required octagon.

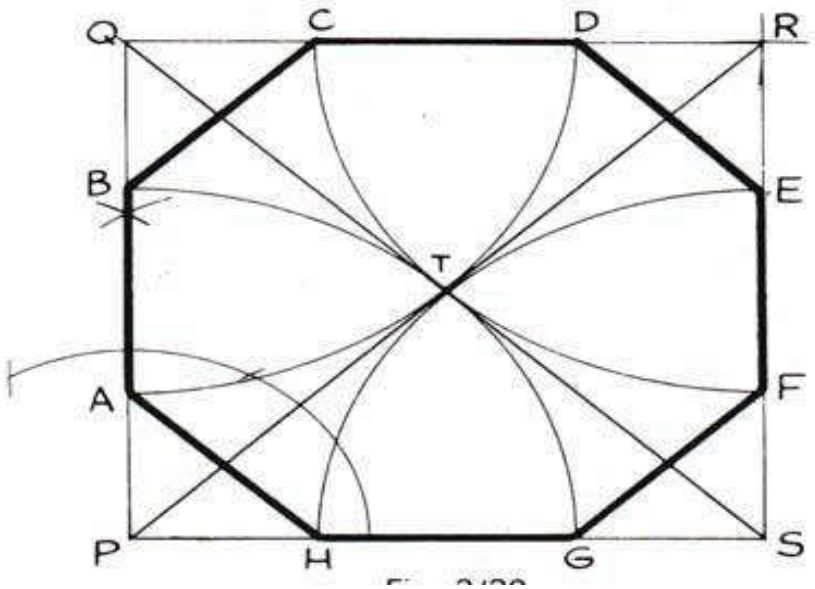


Fig: - 3.2 to construct a rectangular octagon

To construct any given polygon; given the length of a side.

There are three fairly simple way of constructing a regular polygon. Two methods require a Simple calculation and the third requires very careful construction if it is to be exact. All three Methods are shown. The constructions work for any polygon, and a heptagon (seven sides) has been chosen to illustrate them.

Method 1

- Draw a line AB equal in length to one of the sides and produce AB to P.
- Calculate the exterior angle of the polygon by dividing 3600/7 = 51 30/7.
- Draw the exterior angle PBC so that BC = AB.
- Bisect AB and BC to intersect in O.
- Draw a circle, centre O and Radius OA (=OB = OC).
- Step off the sides of the figure from C to D, D to E, etc. ABCDEFG is required Heptagon.

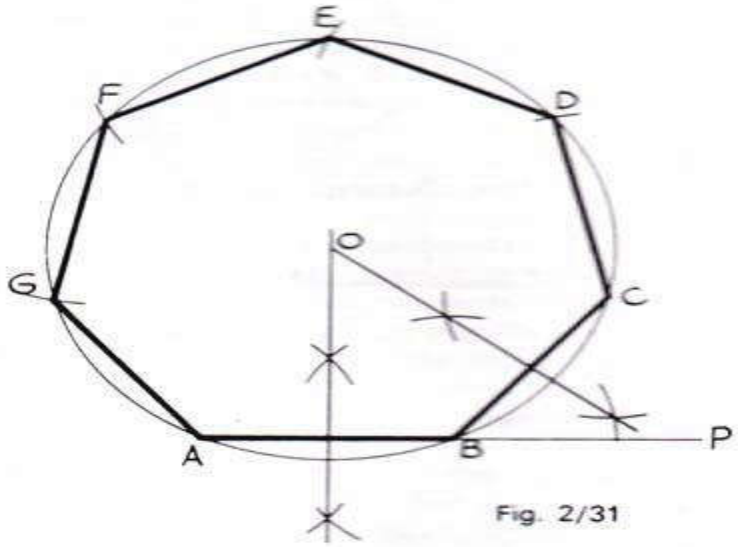


Fig: - 3.3 construct way of polygon

Method 2

- Draw a line AB equal in length to one of the sides
- From a, erect a semi –circle, radius AB to meet BA produced in P.
- Divide the semi circle into the same number of equal parts as the proposed polygon has sides. This may be done by trial and error or by calculation (1800 /7 = 25 50/7 for each arc).
- Draw a line from A to point 2 (For all polygons). This forms a second side to the polygon.
- Bisect AB and A2 to intersect in O.

  With centre O draw a circle, radius OB (=OA = O2).

- Step off the sides of the figure from B to C, C to D etc. ABCDEFG is the required heptagon.

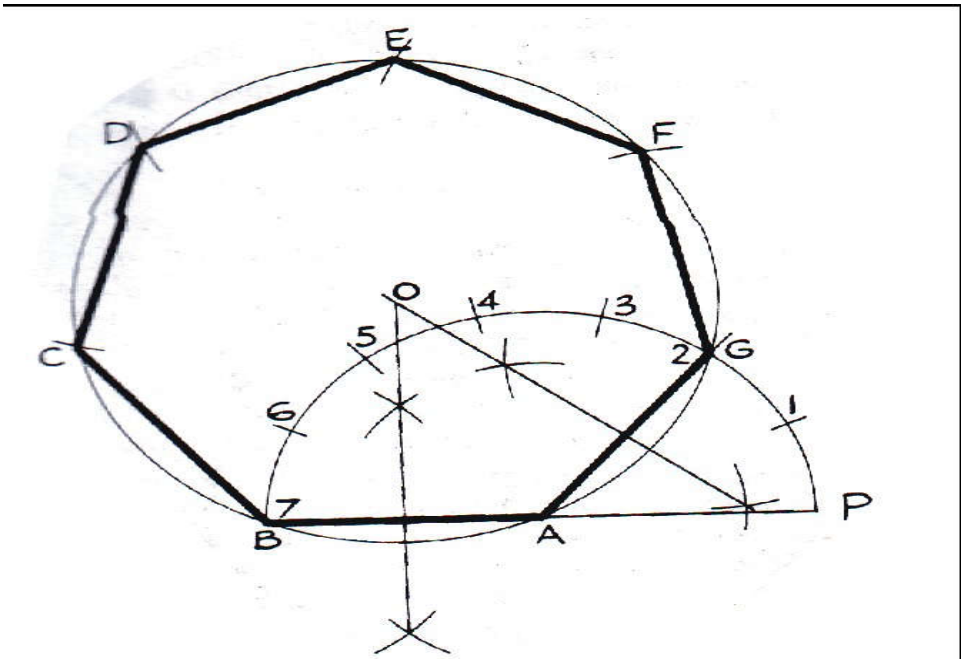


Fig: - 3.4 construct way of polygon

Method 3

- Draw a line GA equal in length to one of the sides
- Bisect GA
- From A construct an angle of 450 to intersect the bisector at point 4.
- From G construct an angle of 600 to intersect the bisector at point 6.
- Bisect between points 4 and 6 to give point 5. Point 4 is the centre of the circle containing a square. Point 5 is the centre of a circle containing a pentagon. Point 6 is the centre of a circle containing a hexagon. By marking off points at similar distance the centers of circles containing any regular polygon can be obtained.
- Mark off point 7 so that 6 to 7 = 5 to 6 (=4 to 5).
- With centre at point 7 draw a circle, radius 7 to A (=7to G).
- Step of the sides of the figure from A to B, B to C, etc. ABCDEFG is the required heptagon

To construct a regular polygon given a diagonal i.e. within a given circle

- Draw the given circle and insert a diameter AM.
- Divide the diameter into the same number of diversions as the polygon has sides.

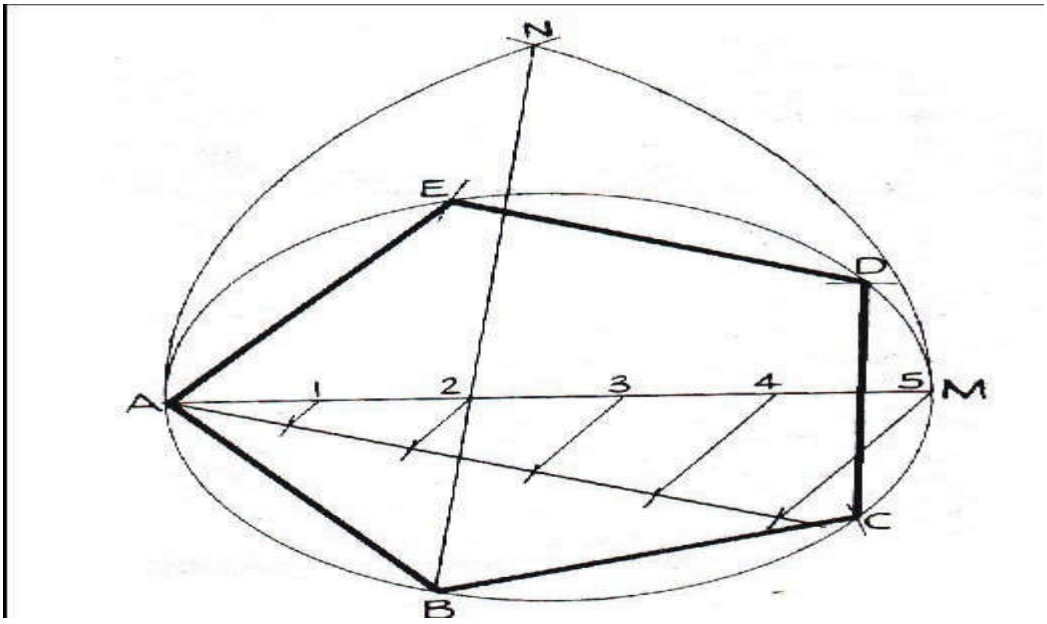


Fig:-3.5 construction way of polygon

- With centre M draw an arc, radius MA. With centre a draw another arc of the same radius to intersect the first arc in N.
- Draw N2 and produce to intersect the circle in B (for any polygon).
- AB is the first side of the polygon. Step out the other side"s BC, CD, etc.
- ABCDE is the required polygon.
- Draw the given circumference AB
- Bisect AB in C.
- With centre C, and radius CA, Draw a semi – circle.
- With centre B and radius BC, draw an arc to cut the semi-circle in D.
- From D draw perpendicular to AB, to cut AB in E.
- With centre E and radius ED draw an arc to cut AB in F. AF is the required diameter.

The rest of this chapter shows the construction for finding circles drawn to satisfy certain gain conditions.

3.3 Sketching Circles and arcs using standard technique.

3.3.1 Circles

Definition

A circle is a plane figure bounded by a curved line called the circumference, which is always equidistant from the Centre.

Properties of a circle

A diameter is a straight line drawn through the Centre meeting the circumference at both ends.

- A radius is a straight line drawn from the Centre to the circumference.
- An arc is part of the circumference.
- A chord is any straight line drawn across the circle meeting the circumference at both ends.
- A tangent is a straight line which touches the circumference.
- It is always at right Angles to the radius.
- A segment is part of a circle bounded by an arc and a chord.
- A sector is a part of a circle bounded by two radii and an arc.
- A quadrant is part of a circle bounded by two radii at right angles and an arc.
- Concentric circles are circles of the same center but different radii
- Eccentric circles are circles of different centers

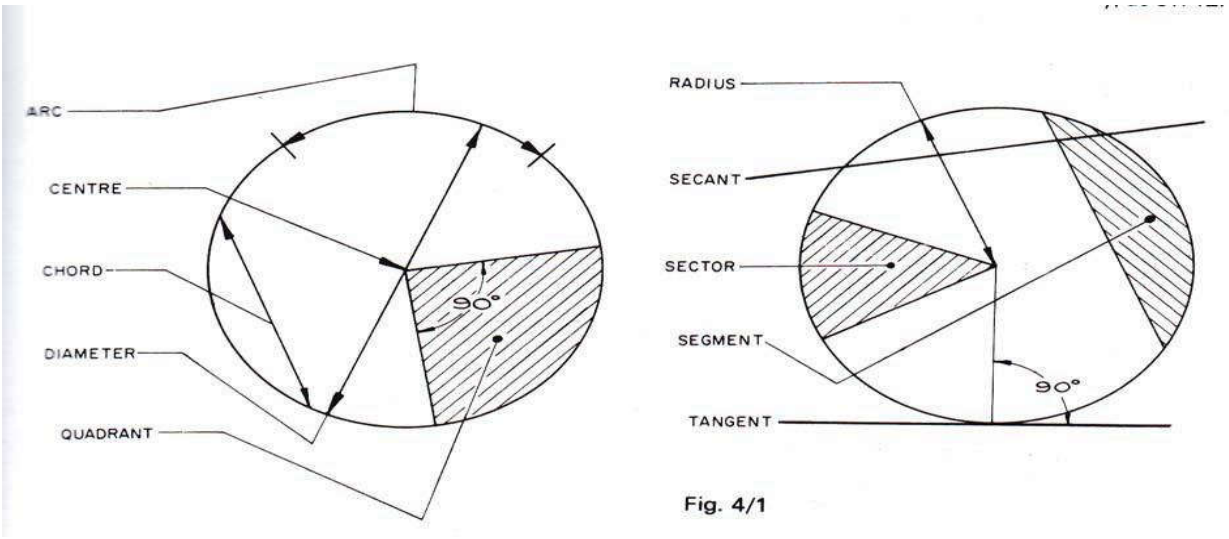


Fig: - 3.6 Concentric circles

Circles in pictorial drawing always become ellipses except it is parallel to normal plane of oblique pictorial.

In isometric drawing, the circle always becomes ellipse.

In oblique drawing when the circle is parallel to normal plane, it is drawn as its true shape and become circle; for other planes other than normal plane the circle becomes ellipse.

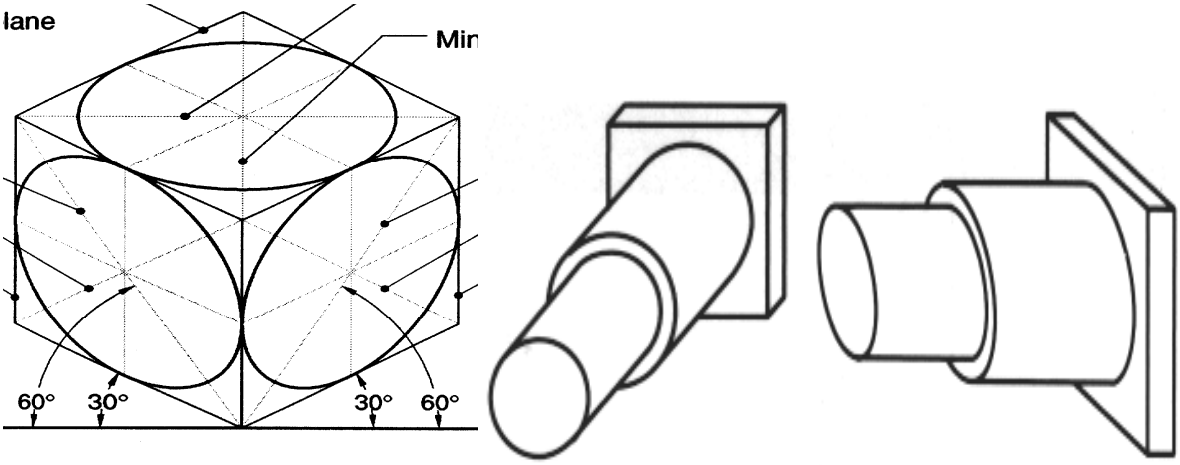


Fig:-3.7 Drawing of **circles**

Methods to Draw Ellipse:

- There are two methods namely, offset method and four center method.
- The **offset method** can be diagonal approach and division approach.

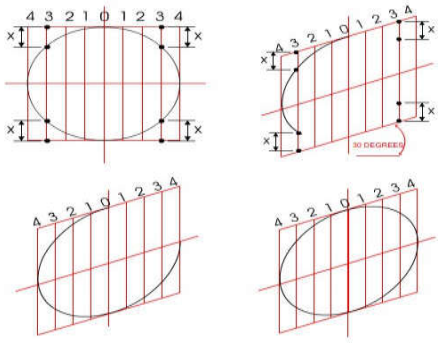


Fig:-3.8 Division approach offset method.

The **four center method** as its name indicates uses four center to draw an ellipse. It is efficient method.

Steps in Four Center Method:

1. Draw a rhombus using the diameter of a circle.
2. Construct perpendicular bisecting lines from each side of rhombus.
3. Draw lines from obtuse angle corners to opposite side of rhombus by intersecting the Midpoint.
4. Locate the four centers.
5. Draw the arcs with this centers and tangent to rhombus.

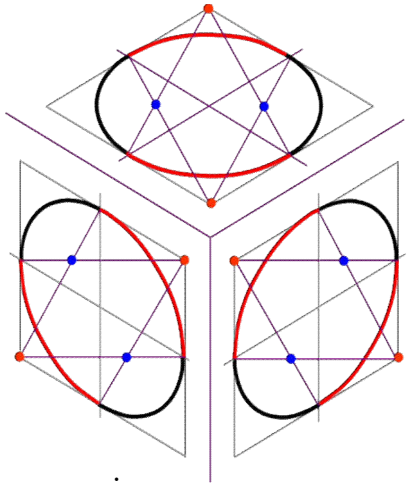


Fig: - 3.9 Four center method.

3.3.2Arcs in Pictorial Drawing

Arcs are usually sketched by locating their centers and then boxing in the enclosing rhombus and tangent to the rhombus.

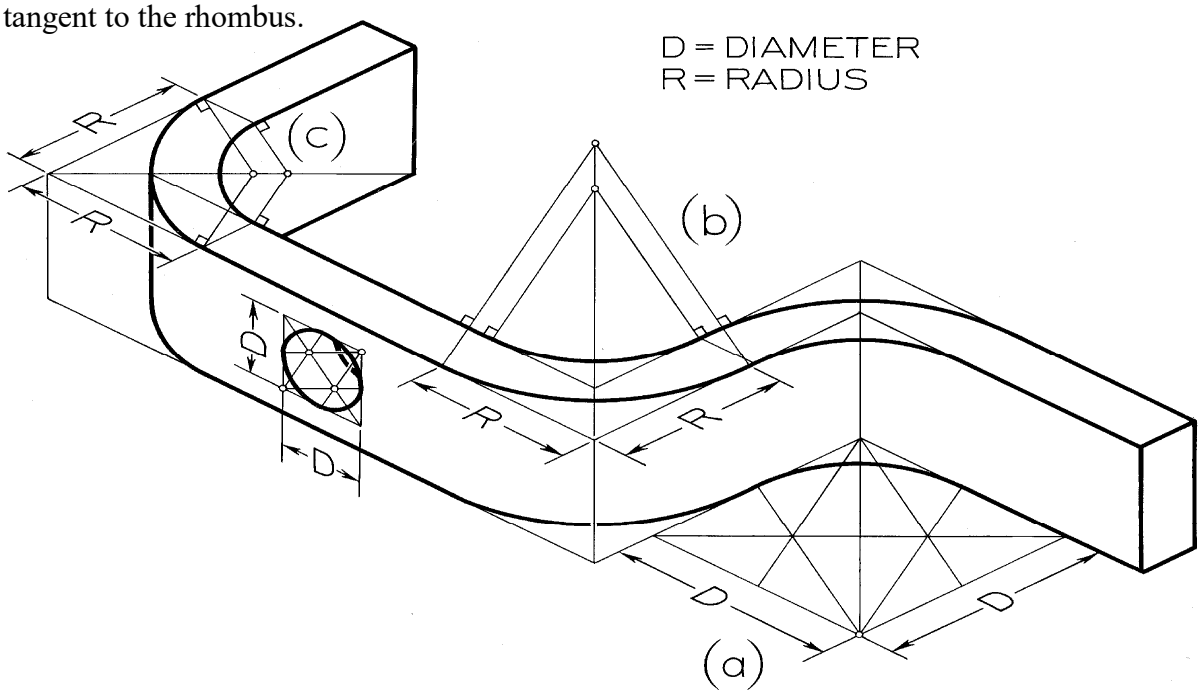


Fig: - 3.10 Arcs in Pictorial Drawing

Self-Check 1	**Written Test**

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. How can we sketch point and line roughly, use one line and point then sketch it? (10pts)
2. Select appropriate drawing instruments and sketch angles, polygons and ellipses?(10pts)

Note: Satisfactory rating – 10 points and above **Unsatisfactory - below 10 points**

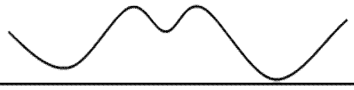
you can ask you teacher for the copy of the correct answers

Information sheet 4	Overview of multi view drawing and sectioning

4.1 Identifying line types appropriately

Just as in English textbook the correct words are used for making correct sentences; in Engineering Graphics, the details of various objects are drawn by different types of lines. Each line has a definite meaning and sense to convey.

Table 4.1 Types of line

TYPE OF LINES	ILUSTRATION	APPLICATION
Continuous thick line		Visible outlines (boundary lines)
Continuous thin line		Dimension lines, leader lines, extension lines, construction lines & hatching (Section) lines.
Continuous thin wavy line (drawn free hand)		Irregular boundary lines, short break lines,
Continuous thin line with ZIGZAG.		Long break lines.
Short dash		Invisible edges
Long chain thin line		Locus lines, center lines,
Long chain thick at ends and thin elsewhere.		Cutting plane lines.
Long thin chain with two dash lines		Phantom line, show alternate position

IS 10714 (Pint 20): 2001 (General principles of presentation on technical drawings) and SP 46:2003 specify the following types of lines and their applications:

- **Visible Outlines, Visible .Edges**: Type 01.2 (**Continuous wide lines**) the lines drawn to represent the visible outlines/ visible edges / surface boundary lines of objects should be outstanding in appearance.
- **Dimension Lines**: Type 01.1 (**Continuous narrow Lines**) Dimension Lines are drawn to mark dimension.
- **Extension Lines**: Type 01.1 (**Continuous narrow Lines**)
- There are extended slightly beyond the respective dimension lines.
- **Construction Lines**: Type 01.1 (**Continuous narrow Lines**) Construction Lines are drawn for constructing drawings and should not be erased after completion of the drawing.
- **Hatching / Section Lines**: Type 01.1 (**Continuous Narrow Lines**) Hatching Lines are drawn for the sectioned portion of an object. These are drawn inclined at an angle of 45° to the axis or to the main outline of the section.
- **Guide Lines**: Type 01.1 (**Continuous Narrow Lines**) Guide Lines are drawn for lettering and should not be erased after lettering.
- **Break Lines**: Type 01.1 (**Continuous Narrow Freehand Lines**) Wavy continuous narrow line drawn freehand is used to represent bre~ of an object.
- **Break Lines**: Type 01.1 (**Continuous Narrow Lines with Zigzags**) Straight continuous ~arrow line with zigzags is used to represent break of an object.
- **Dashed Narrow Lines**: Type 02.1 (**Dashed Narrow Lines**) Hidden edges / Hidden outlines of objects are shown by dashed lines of short dashes of equal lengths of about 3 mm, spaced at equal distances of about 1 mm. the points of intersection of these lines with the outlines / another hidden line should be clearly shown.
- **Center Lines**: Type 04.1 (**Long-Dashed Dotted Narrow Lines**) Center Lines are drawn at the center of the drawings symmetrical about an axis or both the axes. These are extended by a short distance beyond the outline of the drawing.
- **"Cutting Plane Lines**: Type 04.1 and Type 04.2 Cutting Plane Line is drawn to show the location of a cutting plane. It is long-dashed dotted narrow line, made wide at the ends, bends and change of direction. The direction of viewing is shown by means of arrows resting on the cutting plane line.
- **Border Lines**: Border Lines are continuous wide lines of minimum thickness 0.7 mm

Precedence of Lines

1) When a Visible Line coincides with a Hidden Line or Center Line, draw the Visible Line. Also, extend the Center Line beyond the outlines of the view.
2) When a Hidden Line coincides with a Center Line, draw the Hidden Line.
3) When a Visible Line coincides with a Cutting Plane, draw the Visible Line.
4) When a Center line coincides with a Cutting Plane, draw the Center Line and show the cutting Plane line outside the outlines of the view at the ends of the Center Line by thick dashes.

4.2 Identifying orientation of views.

4.2.1 Orthographic Projections

To present an object in a unique way, generally more views (and sometimes sections) are required. In orthographic projection, the views are seen in directions that make right angles (i.e. 90o) with each other. The number of views needed should be sufficient to represent the object completely and conveniently, but it should be kept to the minimum. For most purposes, three views are usually sufficient.

- ✓ Engineering (Technical) drawings usually utilize orthographic views (OV) rather than pictorial views
- ✓ Orthographic (OV) help to record the shapes of objects exactly and completely
- ✓ OV is a two-dimensional (2-D) drawing. It shows only one side of an object and two of its overall dimensions
- ✓ A minimum of two OV is required to show the three dimensions of any object and therefore to describe its shape completely Some features of the object that do not directly appear on viewing the object from any specific direction (known as hidden details) are shown on the drawing as dotted lines.

Naming of Views

In orthographic projection, three views are normally drawn. The three chosen views may be any of the six hypothetical faces of the object. These views are named as shown below.

The Front View – abbreviated as FV, is that view of utmost importance in representing the object (normally the most complicated of all the views) as seen when the object is placed directly in front of the viewer. This view generally serves to represent the object (e.g. a work piece) in the most common position in which it is used. It is normally the first view to be drawn – other views following thereafter. **The Rear View** – RV (EFGH) is directly opposite the FV at the back of the object.

The Right Hand Side View – RHSV (BFGC) and **the Left Hand Side View** – LHSV (AEHD) appear on the right and left sides of the object, respectively. **The Top** and **Bottom Views** are at the top and bottom sides of the FV. As you must have noted, these six views are at right angles to one another.

Standard Orthographic Projections

Two standards are commonly in use in orthographic projection of drawings; the First Angle Projection (European projection) and the Third Angle Projection (American projection). It should be noted that corresponding views are identical in both methods of projection except for their relative positions on the drawing paper.

The First Angle Projection

In here, the front view (A) is the basis (reference) and the other views are drawn as „shadows" of that view. That is, the left hand side view for instance is drawn on the right side of the front view. Similarly the top view (plan) is drawn at the bottom of the front view, etc.
In here, the front view is the basis (just as before) but the other views are drawn as „reflections" of that view. The left hand side view is drawn on the left hand side of the front view. Similarly, the top view (plan) is drawn at the top of the front view.

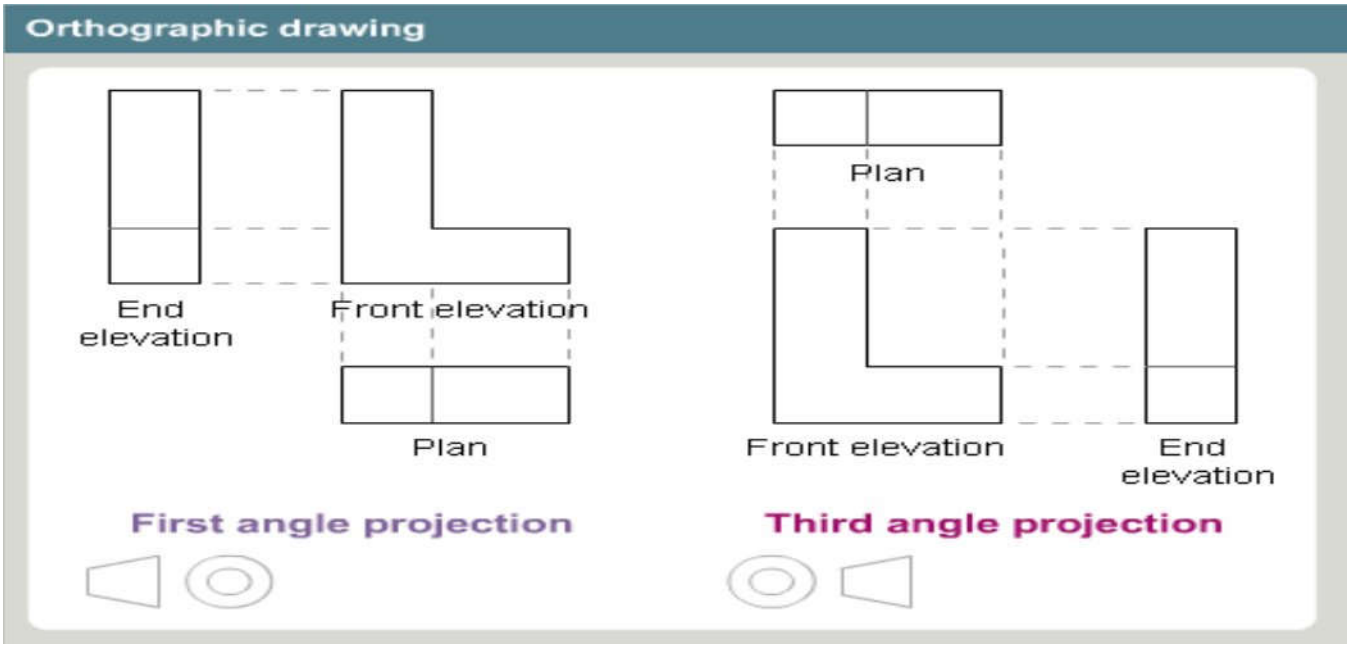


Fig:-4.1 orthographic drawing

4.3 Sketching the Auxiliary views using standard technique.

The conventional orthographic views, viz, front, top and side views may not be sufficient always to provide complete information regarding the size and true shape of the object, especially when it contains surfaces inclined to the principal planes of projections. The true shape of an inclined surface can only be obtained by projecting it on to an imaginary plane which is parallel to it. This imaginary plane is called an auxiliary plane and the view obtained on it is called the auxiliary view.

As the auxiliary view only shows the true shape and details of the inclined surface or feature, a partial auxiliary view pertaining to the inclined surface only is drawn. Drawing all other features lead to confusion of the shape description.

- ✓ Inclined planes and oblique (neither parallel nor perpendicular) lines appear foreshortened when projected to the principle planes of projection.
- ✓ To obtain a true size view, auxiliary views are created using similar techniques as for creating standard views, unfolding about an axis…

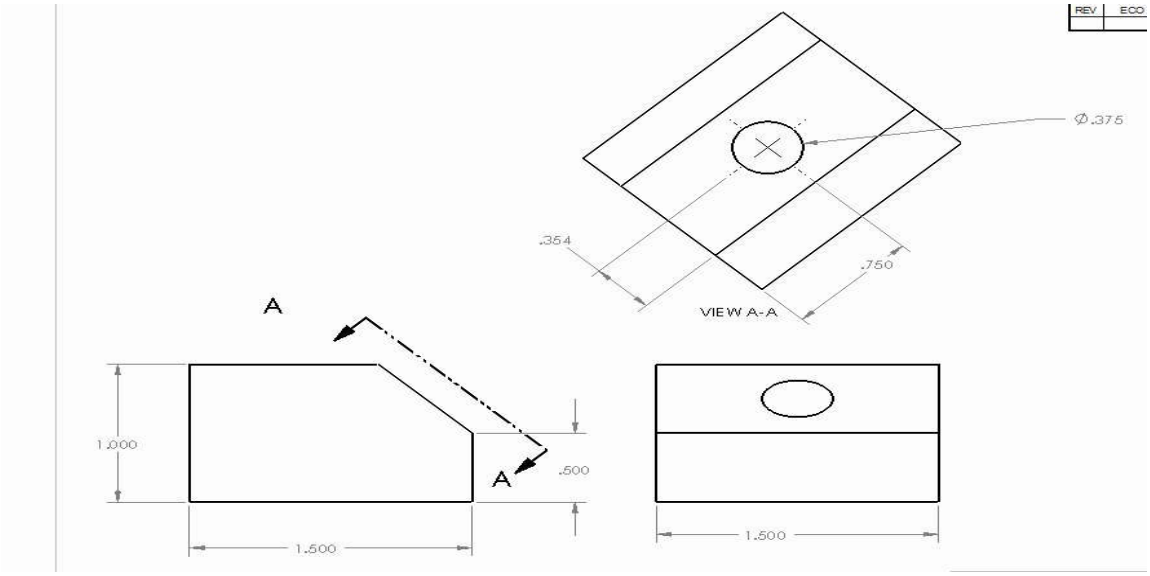


Fig: 4.2 Auxiliary views

4.3.1 Types of Auxiliary Views

Auxiliary views may be classified, based on the relation of the inclined surface of the object with respect to the principal planes of projections.

1. *Auxiliary Front new*

In this case the auxiliary front view of an object, projected on an Auxiliary Vertical Plane (AVP), inclined to VP and perpendicular to HP. Here, the auxiliary front view is projected from the top view, and its height is same as the height of the front view.

2. *Auxiliary Top new*

The auxiliary top view of an object, projected on an auxiliary vertical plane inclined to VP and perpendicular to H.P. The diagonal of the object is vertical and its front view is given. The auxiliary top view is projected from the front view and its depth is the same as the depth of the top view.

3. *Primary and Secondary Auxiliary news:*

The auxiliary view obtained on either AIP or AVP is known as primary auxiliary view. The secondary auxiliary view is required to obtain the true shape of the surface when the surface of an object is inclined to both HP and VP. !

4. *Auxiliary Projection of Regular Solids*

Projection of planes and of regular solids inclined to one or both the principal planes of projection may be obtained by the use of auxiliary planes. This method is known as the change of reference line method.

4.4 Dimensioning multi view drawing

Drawing of a component, in addition to providing complete shape description, must also furnish information regarding the size description. These are provided through the distances between the surfaces, location of holes, nature of surface finish, type of material, etc. The expression of these features on a drawing, using lines, symbols, figures and notes is called dimensioning.

4.4.1 Principles of Dimensioning

Some of the basic principles of dimensioning are given below:

1. All dimensional information necessary to describe a component clearly and completely shall be written directly on a drawing.
2. Each feature shall be dimensioned once only on a drawing, i.e., dimension marked in one view need not be repeated in another view.
3. Dimension should be placed on the view where the shape is best seen.

4.As far as possible, dimensions should be expressed in one unit only preferably in millimeters, without showing the unit symbol (mm).

5. As far as possible dimensions should be placed outside the view.

6. Dimensions should be taken from visible outlines rather than from hidden lines.

7. No gap should be left between the feature and the start of the extension line.

8. Crossing of centre lines should be done by a long dash and not a short dash.

4.4.2 Execution of Dimensions

1. Projection and dimension lines should be drawn as thin continuous lines. Projection lines should extend slightly beyond the respective dimension line. Projection lines should be drawn perpendicular to the feature being dimensioned. If the space for dimensioning is insufficient, the arrow heads may be reversed and the adjacent arrow heads may be replaced by a dot. However, they may be drawn obliquely, but parallel to each other in special cases, such as on tapered feature.

2. A leader line is a line referring to a feature (object, outline, and dimension). Leader lines should be inclined to the horizontal at an angle greater than 30°. Leader line should

terminate:

(a) With a dot, if they end within the outline of an object.

(b) With an arrow head, if they end on outside of the object.

(c) Without a dot or arrow head, if they end on dimension line.

Dimension lines should show distinct termination in the form of arrow heads or oblique strokes or where applicable an origin indication. The arrow head included angle is 15°. The origin indication is drawn as a small open circle of approximately 3 mm in diameter. The proportion length to depth 3: 1 of arrow head is shown.

When a radius is dimensioned only one arrow head, with its point on the arc end of the dimension line should be used .The arrow head termination may be either on the inside or outside of the feature outline, depending on the size of the feature.

4.4.3 Methods of Indicating Dimensions

The dimensions are indicated on the drawings according to one of the following two methods.

Method -1 (Aligned method)

Dimensions should be placed parallel to and above their dimension lines and preferably at the middle, and clear of the line.

Method -2 (uni-directional method)

Dimensions should be indicated so that they can be read from the bottom of the drawing only. Non-horizontal dimension lines are interrupted, preferably in the middle for insertion of the dimension.

Note: Horizontal dimensional lines are not broken to place the dimension in both cases.

4.4.4 Arrangement of Dimensions

The arrangement of dimensions on a drawing must indicate clearly the purpose of the design of the object. They are arranged in three ways:

1. Chain dimensioning 2. Parallel dimensioning 3. Combined dimensioning.

1. **Chain dimensioning**

Chain of single dimensioning should be used only where the possible accumulation of tolerances does not endanger the fundamental requirement of the component.

2. **Parallel dimensioning**

In parallel dimensioning, a number of dimension lines parallel to one another and spaced out, are used. This method is used where a number of dimensions have a common datum feature.

4.5 Sectioning

For complex components with a number of hidden details, external views may not be enough to enable machining of such components. In such cases, sectioning is recommended. Sectioning is achieved by assuming an imaginary cutting/sectioning plane (or several planes) passing through the detail of interest. The "cut section", as it would appear, is drawn. The position of the cutting plane is indicated by a thin, long chain, line with thick extremities. This chain line is labeled with capital letters with the direction of viewing indicated by arrows. The capital letters are placed behind the arrows in the direction of viewing. The layout of sections and the designation/naming of sectional views is the same as for the corresponding ordinary external views.

General Hints

- Sometimes, only a small portion of the component is sectioned to indicate the feature of interest
- Parts (features) behind the sectioning plane are not shown, except when clarity requires this
- Hatch the solid part of the component that is "cut through" by the sectioning plane. Hatching lines are thin, parallel lines usually drawn at an angle of 45o to the outlines or the center lines of the object. The spacing of these lines depend on the size of the drawing
- Some standard parts/features are usually not sectioned (e.g. shafts, bolts, nuts, rivets, keys, pins, ridges, ribs, etc)
- For symmetrical components/features, only half of the component is sectioned along the line of symmetry
- Sections through two intersecting cutting planes are drawn as if these sections were in one plane

- ✓ We have covered the basic method of representing an object by projecting views. This allows us to see the external features of an object.
- ✓ Often times it is necessary to view the internal features, this is accomplished by slicing through the object and producing a sectional or section view
- ✓ Section views can reduced the number of views of many axisymmetric parts to a single view

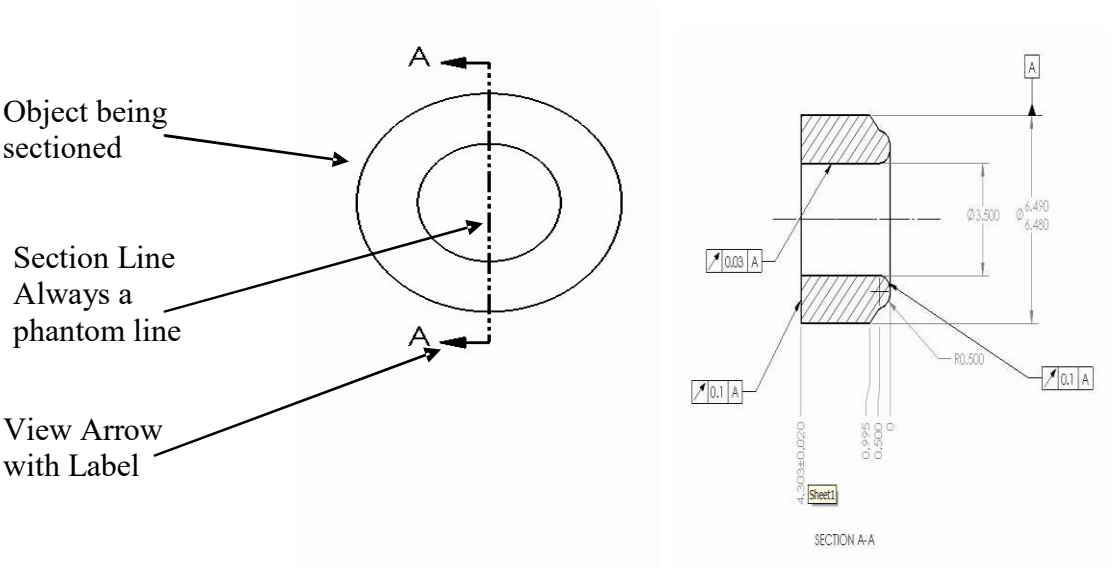


Fig 4.3 Sectional views for regular objects

- ✓ Sectional views are extremely useful in minimizing the number of projected views.
- ✓ Section views provide clear and unambiguous representation of internal features

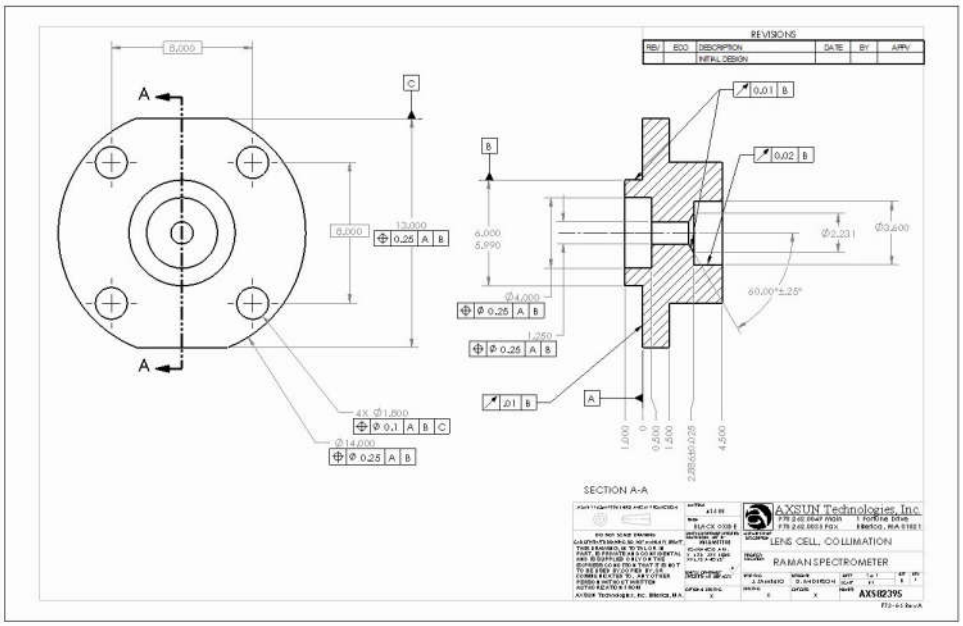


Fig 4.4 Sectional views for irregular objects

Types of Sections

The following are the most common types of sectional views:

- ❖ Full section
- ❖ Half section
- ❖ Offset section
- ❖ Broken-out section
- ❖ Revolved section
- ❖ Removed section

1-Full Section:

- In a full sectional view, the cutting plane cuts across the entire object.
- Half of the object is removed.
- Interior lines behind cutting plane became visible.
- No hidden lines on the sectional view, if possible.
- Show the cutting plane in the top view or side view; and make a full section in the front view.

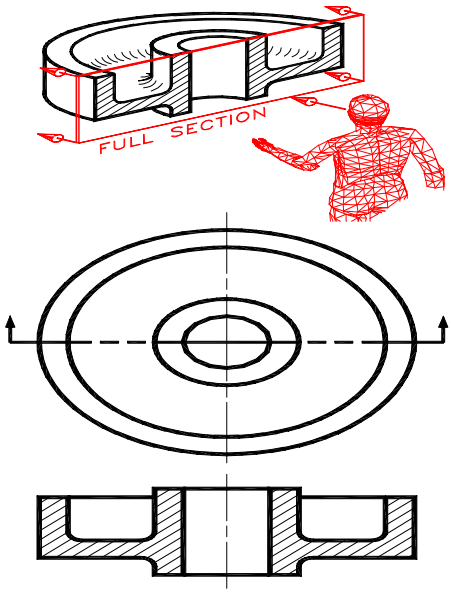


Fig:-4.5 full sectional view

2-Half Section

- Half section used mainly for symmetric objects.
- In a half sectional view, the cutting plane do not cut across the entire object. It cuts only

half way and intersect at the centerline.

- A quarter of the object is removed.
- Hidden lines are omitted.
- Show the cutting plane in the top view or side view; and make a half section in the front view.

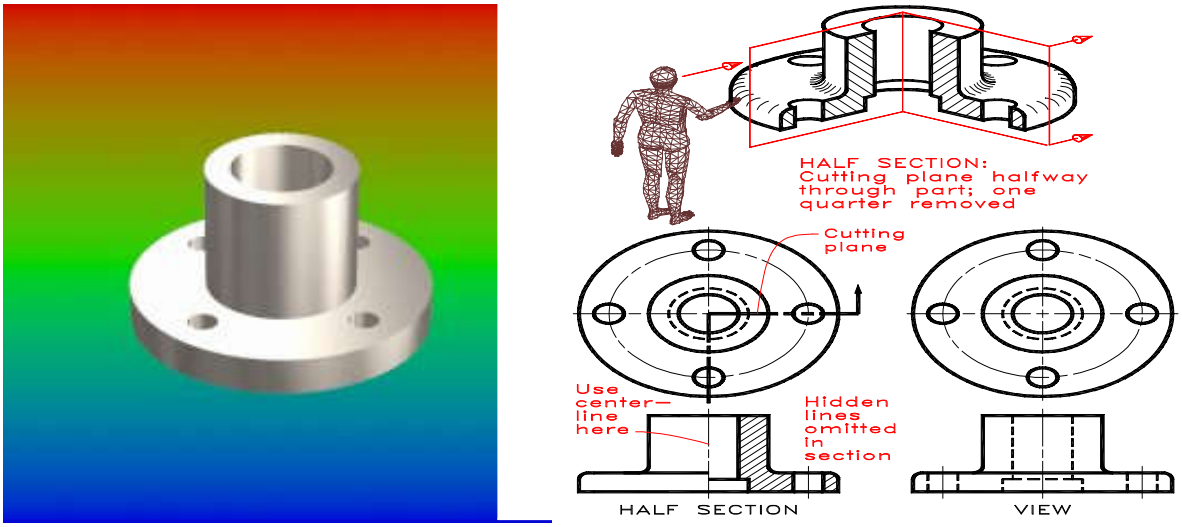


Fig:-4.6 half sectional view

3-Revolved Section:

- A revolved section is created by passing a cutting plane through the cross section of the object, then revolving the cross section by 90°.
- Revolved section is used to show the cross-sectional shape of a bar, spoke, or arm in a single view.

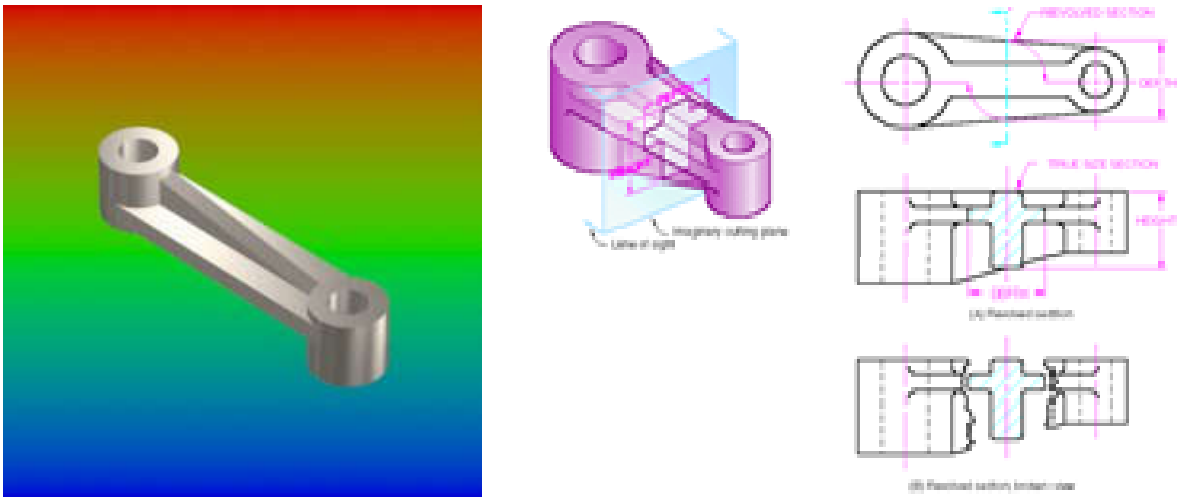


Fig:-4.7 Revolved sectional view

4-***Removed Section:***

- A removed sectional view is created by making a cross section, then moving it to an area adjacent to the view.
- Removed section is like revolved section but moved aside.

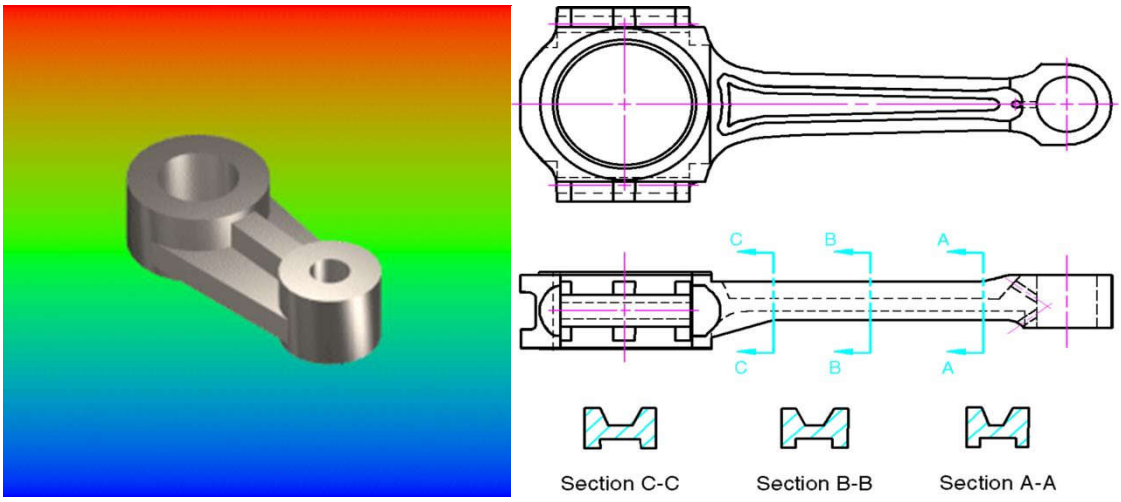


Fig:-4.8 Removed sectional view

- Offset sections are used to show interior features that do not lie along a straight line.
- In offset section plane, the cutting plane is bend to show more features.
- Offset sectional view does not denote location of offset.
- Show the cutting plane in the top view or side view; and make an offset section in the front view.

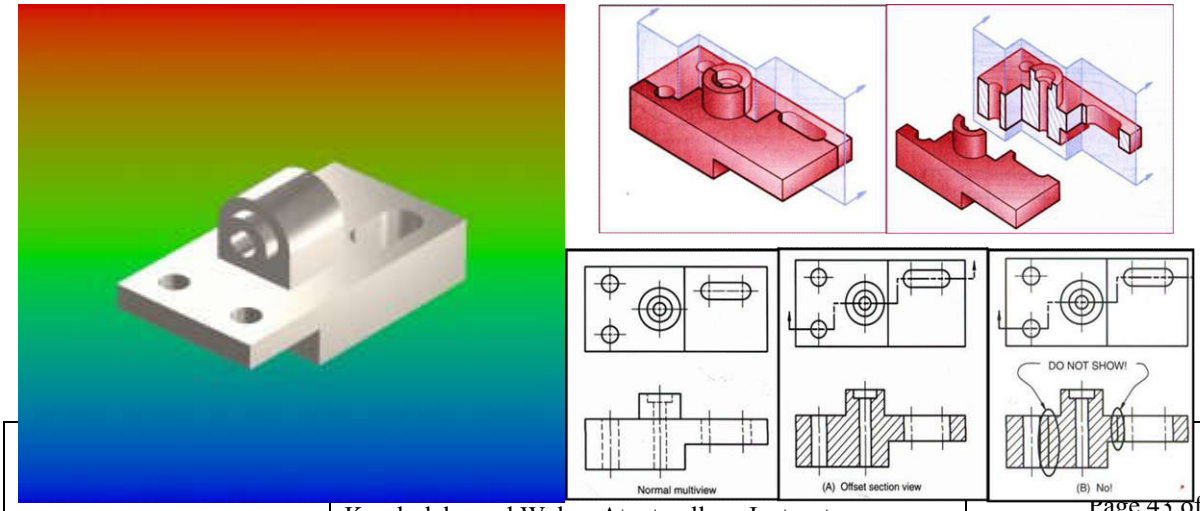
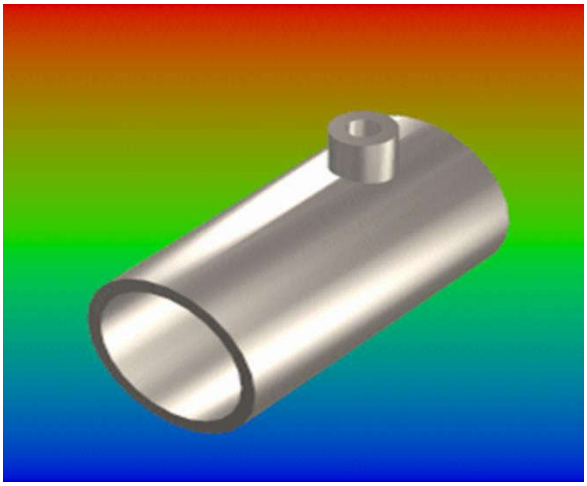


Fig:-4.9 Offset sectional view

6-Brocken-out Section:

- A broken-out sectional view is created by breaking off part of the object to reveal interior features.

  Used to section a small portion of a drawing.



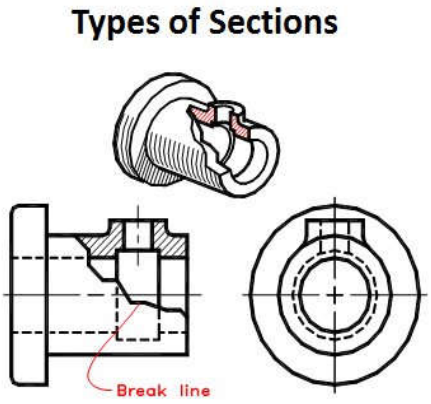
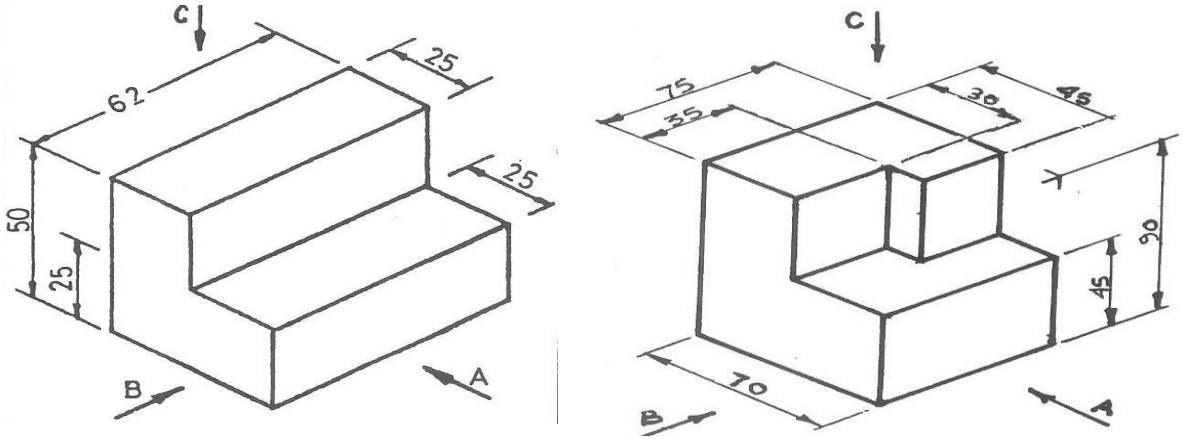


Fig:-4.10 Broken-out sectional view

Self-check

1) Study the two (2) isometric pictorial drawing of components and by using scale 1:1 and third angle of projection draw the following:

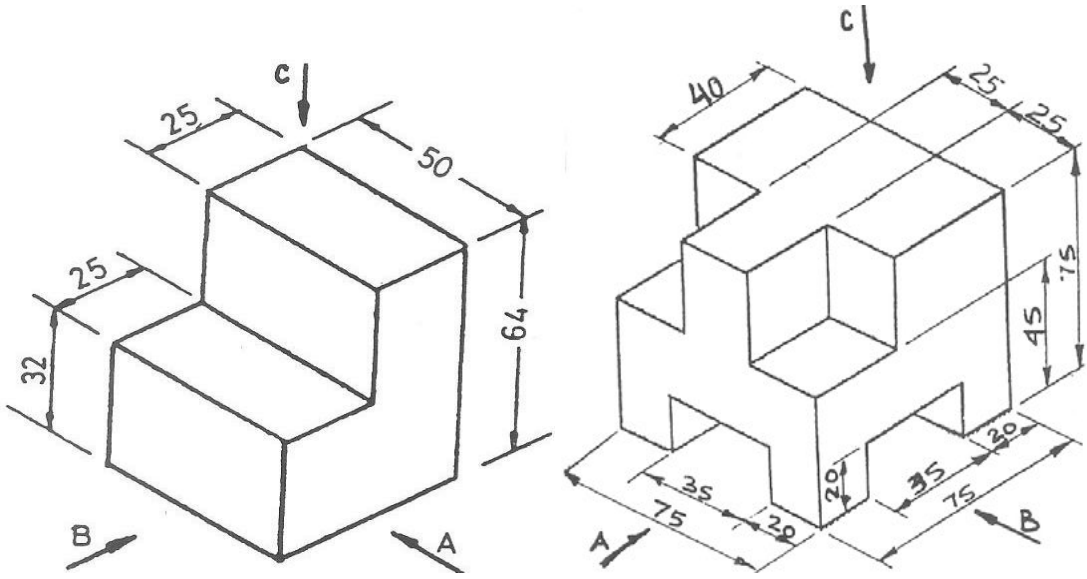
- Front view- Side view - Top view



Note: All dimensions are in mm

2) Study the two (2) isometric pictorial drawing of components and by using scale 1:1 draw the following:

-Using 1st angle of projection draw, 1- Front view 2 -Side view 3- Top view



Note: All dimensions are in mm

Self-Check 1	**Written Test**

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What are orthographic projections, what are their standards? (10pts)
2. What are auxiliary views, what are their standards?(5pts)
3. List the types auxiliary views and explain?(5pts)
4. List and explain the ways of dimensioning multiple views?(5pts)
5. What are section views, list and explain the types?(5pts)

Note: Satisfactory rating – 15 points and above **Unsatisfactory - below 15 points** you can ask you teacher for the copy of the correct answers

Information sheet 1	**Determining axonometric projection drawing**

Introduction

In order to obtain a drawing that pictorially visualizes the object, several forms of one plane conventional or projection picture methods are used. In these methods, the third dimension is taken care of by turning the object so that its 3 dimensions are visible or by using oblique projection. In these types of drawings, only the visible edges are shown.
Mechanical or structural details that are not clear in orthographic views can be drawn pictorially or supplemental pictorial views can be provided.
There are 3 main kinds of pictorial drawing: Axonometric, oblique and perspective. These types are summarized in the figure below.

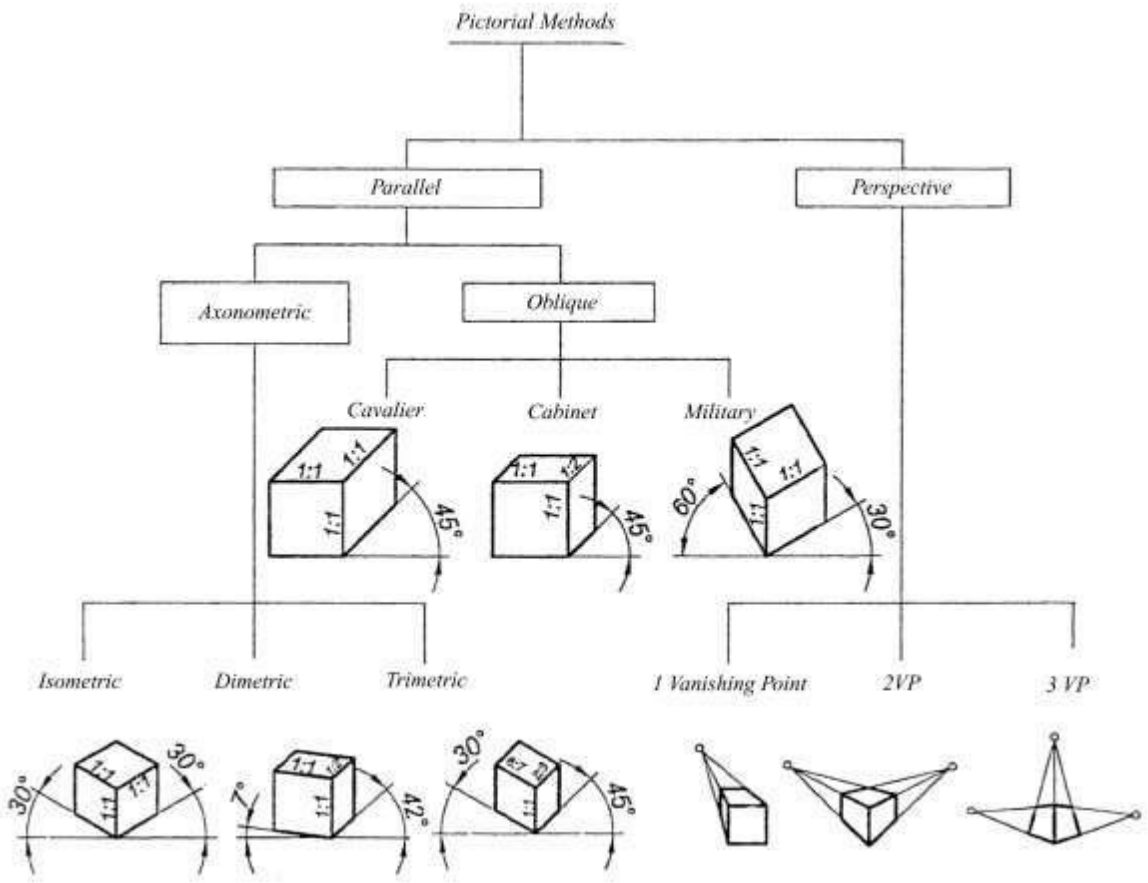


Fig 5.1 types of pictorial drawing

5 Axonometric (Pictorial) Projections

Axonometric Projection: Theoretically, it is an orthographic projection in which only one plane is used, the object is turned so that three faces show. Depending on the angles used for turning the object, these types are named as: isometric, dimetric and trimetric axonometric projections.

These are drawings in which the object is drawn in three dimensions (3-D), i.e. three sides of the object appear in one drawing. Normally only one drawing is prepared /used.

- They are used extensively in artistic drawing.
- A three dimensional view (i.e. shows length, width and height of the object simultaneously)
- Provides only a general impression of the shape of the object by allowing the observer to see three of its sides as well as its three overall dimensions.
- An exact and complete description of its shape, particularly as applied to its slots on the underside is lacking.

5.1 Assessing isometric projections

In isometric projection, all dimensions along all the three axes are drawn to TRUE SIZE. Isometric projection is preferred when the three views of the object are of equal importance for accurate presentation of the object. How do we draw an isometric axonometric projection of an object? The steps are summarized in the figure below:

Step1: Using a 30o triangle, 2 lines are drawn to the right and left side of vertical line and the object is placed on the vertex.
Step 2: A cubic figure is drawn using the dimensions of the object.
Step 3: The primary lines are drawn.
Step 4: The invisible lines are drawn very lightly.
Step 5: The unnecessary lines are erased.
Step 6: The drawing is finished using a 0.5 tipped pencil.

Example: Cube of length L

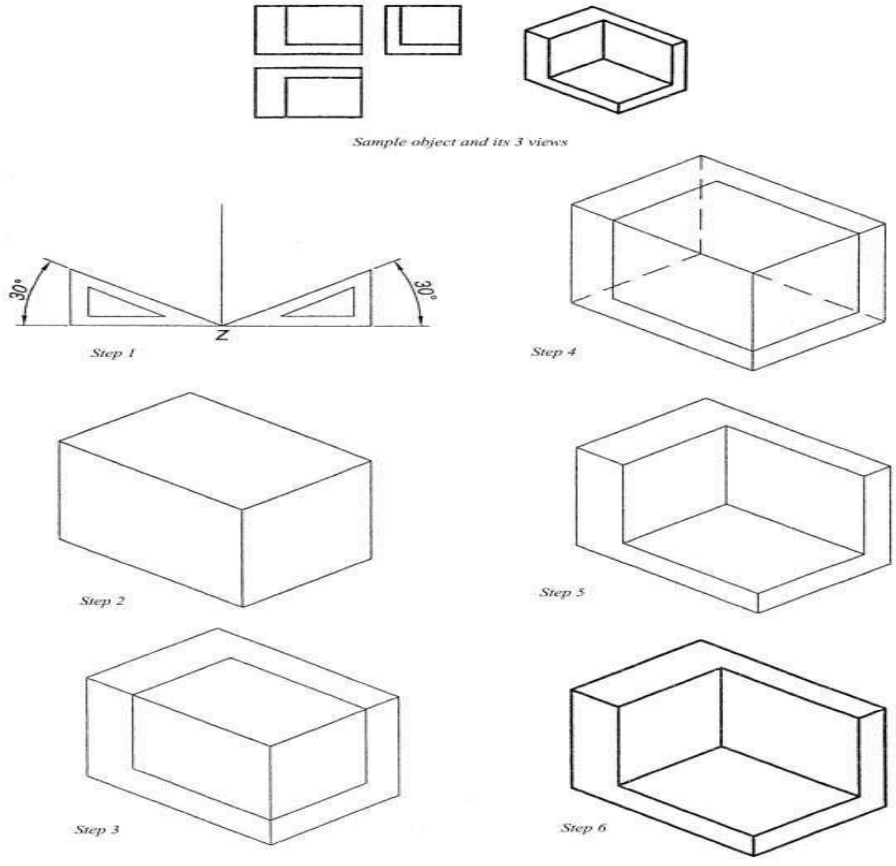


Fig 5.2 isometric projections

5.2 Assessing di-metric projections

Two of the principal faces and axes are equally inclined to the plane of projection.

In di-metric projection, all dimensions along two axes are drawn to TRUE SIZE. The dimensions along the third axis are HALVED. This projection is preferred when one view of the object is to be emphasized than the other two views (i.e. when that one view is of more interest than the other views).

Example: A cube of length L

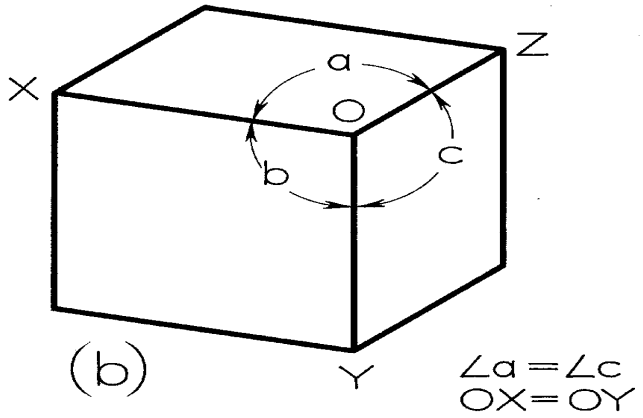


Fig 5.3 Di-metric projections

5.3 Assessing tri-metric projections

All three principal faces and axes make different angles with the plane of projection.

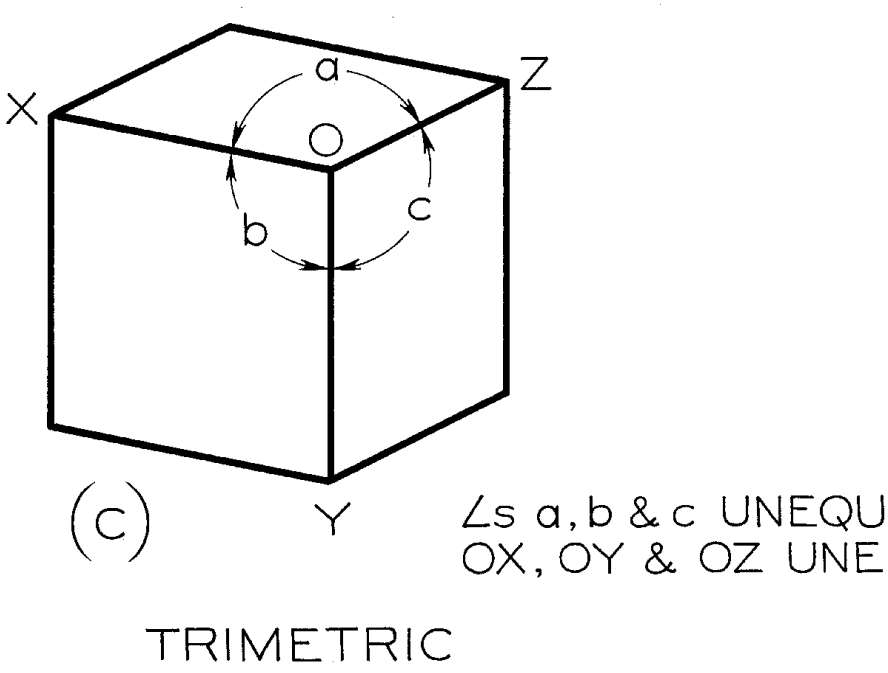
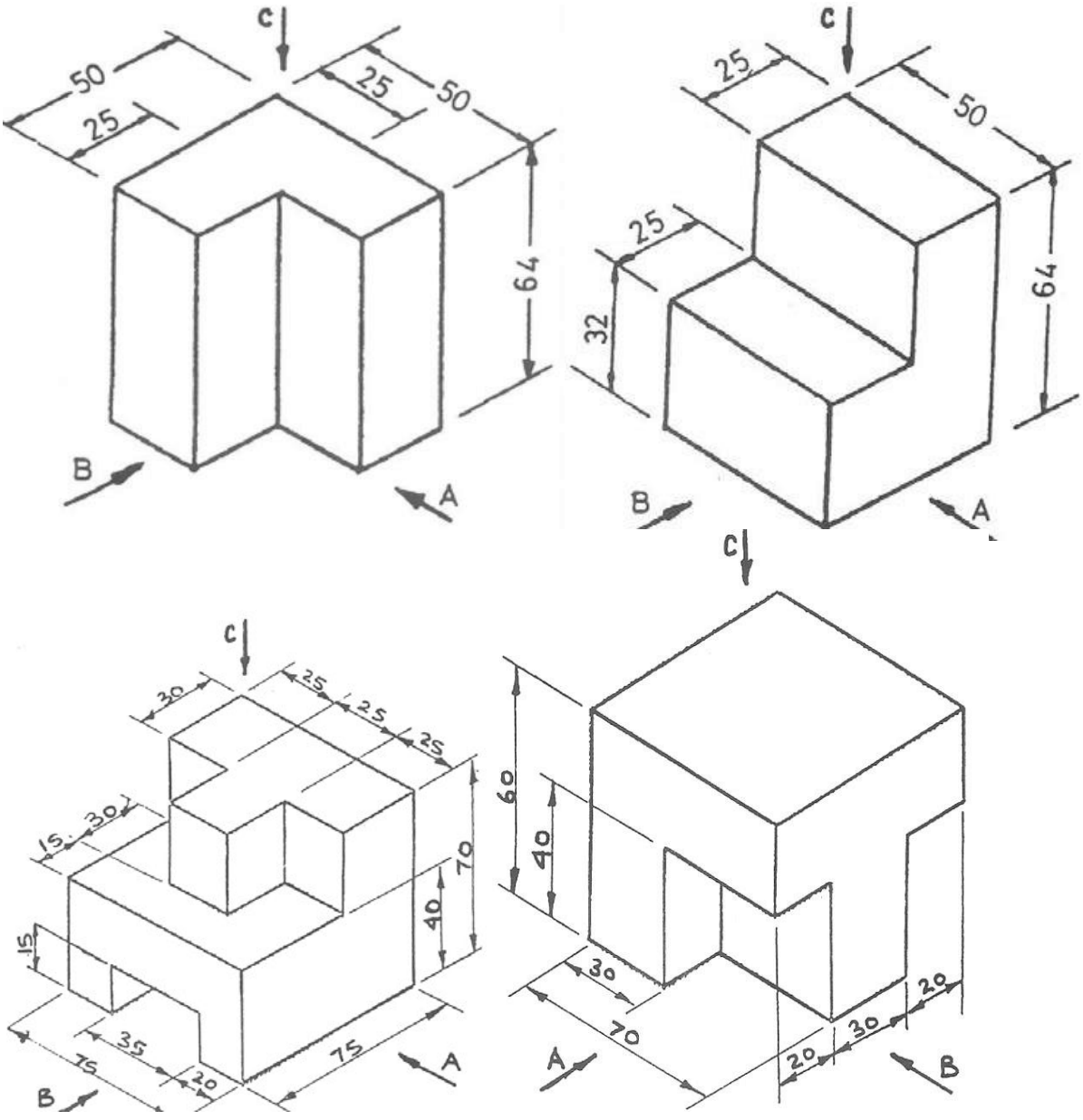


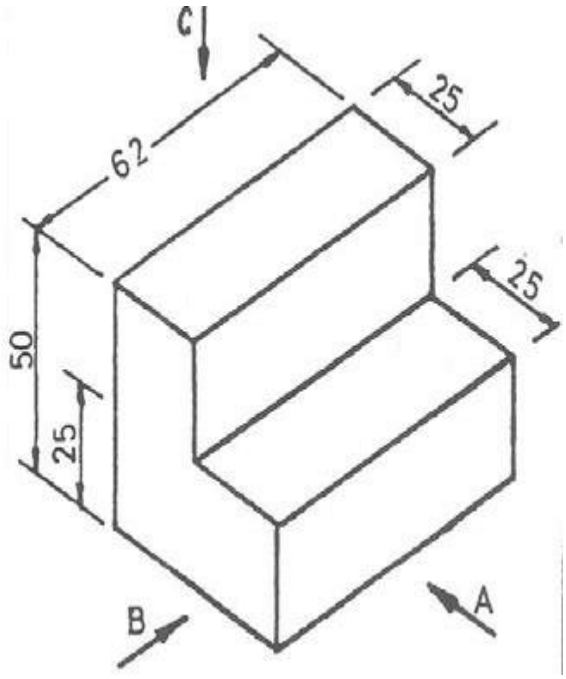
Fig 5.4 Tri-metric projections

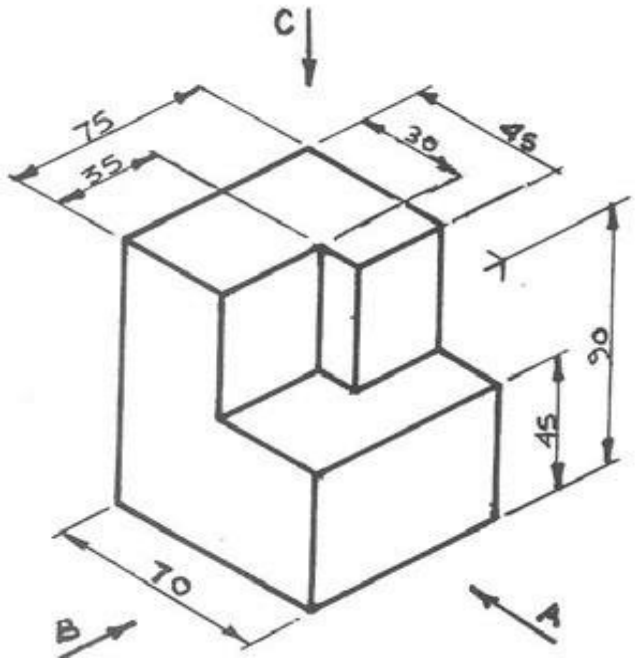
Self-check

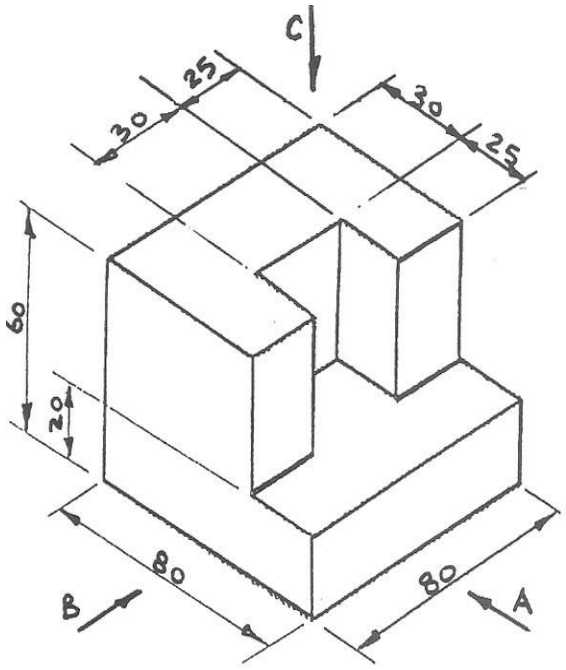
1) **Study the following drawings and by using proper drawing tools and scale 1:1 re-draw the isometric pictorial drawings.**

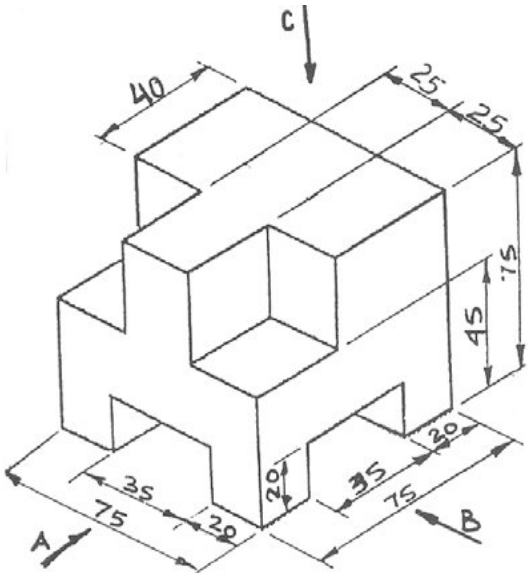
Note: All dimensions are in mm



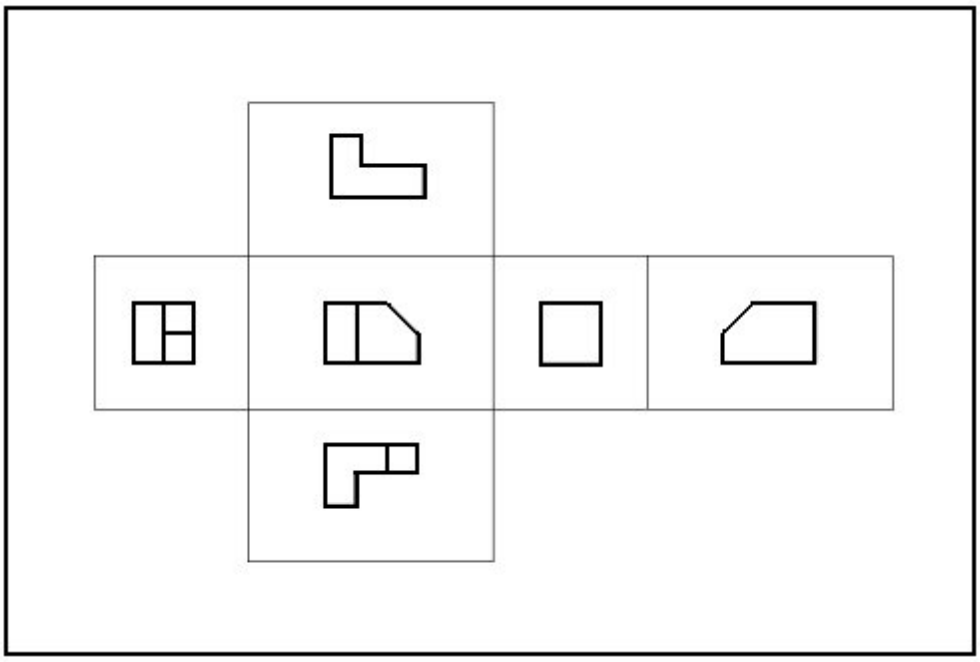








2) Draw an isometric projection from the given views.



Self-Check 1	**Written Test**

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What are axonometric (pictorial) projections, explain? (10pts)
2. How can we asses axonometric and di-metric projections?(5pts)

Note: Satisfactory rating – 7.5 points and above **Unsatisfactory - below 7.5 points** you can ask you teacher for the copy of the correct answers