Foundry Works

Level-I

Based on March 2022, Curriculum Version 1

Module Title: - Interpreting Technical Drawings

Module Code: IND FDW1 M01 0822

Nominal Duration: 100 Hours

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Contents Page

Acronyms

SOP	Standard operating procedures
FDW1	Foundry work level 1
IND	Industrial
LAP	Learning activities performance
LO	Learning outcome
M01	First module
PPE	Personal protective equipment
TTLM	Teaching training and learning materials
TVT	Technical and vocational training
UC	Unit of competency

Acknowledgments

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVT instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Introduction to the Module

This training material is designed to incorporate the knowledge, skill, and attitude of the trainees to interpret technical drawing within the nominal time duration of **100** hours. In this module, the trainees will understand the uses of interpreting technical drawing and escalate the importance of drawing for the communication of engineers in the work area. On the completion of theoretical training and through the hands-on practice given, the trainees will acquire some of the basic skills and techniques of drawing representation and interpretation of parts. To this end, the module focuses on the fundamental aspects and practices in of variety of drawing representations.

In the foundry field; interpreting drawing helps to represent different industrial products. Technical drawing contributes to the manufacturing sector to communicate in the production process. It gives a detail information of an object, with dimensional tolerances, symbols of surface finish. Moreover, many foundries use drawing for practical work process. This module is designed to meet the industry requirement under the foundry works based on the occupational standards, particularly for the unit of competency; **Interpreting Technical Drawing** to achieve learning outcomes expected in level-I.

This module covers the units including:

- Identifying drawing requirements
- Identifying views, standard symbols and lines
- Preparing technical drawing
- Interpreting technical drawing

The learning objectives of the module help the trainees to:

- Identify drawing requirements
- Identify views, standard symbols and lines
- Prepare technical drawing
- Interpret technical drawing

Module Instruction

For effective use of this module, trainees are expected to follow the module instructions including:

1. Read the information written in each unit.
2. Accomplish the Self-checks at the end of each unit.
3. Perform Operation Sheets which were provided at the end of units.
4. Do the learning activity performance (LAP) test giver at the end of each unit and
5. Read the identified reference books to get more knowledge as well as to do examples and exercise.

Unit one: Identify drawing requirements

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Following standard operating procedures (SOPs)
- Compiling work health and safety (WHS) requirements
- Identifying job requirements from specifications
- Considering concepts of fit and tolerances

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

- Follow standard operating procedures (SOPs)
- Compile work health and safety (WHS) requirements
- Identify job requirements from specifications
- Consider concepts of fit and tolerances

1.1 Standard Operating Procedures (SOPs)

Standard operating procedures depends on the type of task. The SOP in the case of technical drawing is doing the drawing following standard procedures. The type of SOP is not identical with any one of the type of operations. Technical drawing can be defined as the graphic representation of an object, concept or idea using a universal language that consists of graphic symbols produced with the aid of drawing equipment/tools that can be used to measure straight and curved lines according to specified dimensions ,scales, and codes of practice.

Standard operating procedure (SOP) is a written/drawn document composed of step-by-step instructions used to complete a routine operational task. Organizations follow their own SOPs to achieve efficiency, uniform performance, quality control, and regulatory compliance. Put simply, standard operating procedures make business tasks easier for workers to complete. They indicate what a complex task entails, how it should be approached, and what to do in the event of unusual circumstances. SOPs also come in handy when employees are out sick, taking personal days, or attending conferences. Available workers can fill in and complete unfamiliar tasks by simply following the documented processes.

Graphic representation means dealing with the expression of ideas by lines or marks impressed on a surface. A drawing is a graphic representation of a real thing. Drafting, therefore, is a graphic language, because it uses pictures to communicate thoughts and ideas. Because these pictures are understood by people of different nations, drafting is referred to as a universal language. Engineering drawing is the common language of engineering and describes the process of creating drawings for any engineering or architectural application. Engineering drawings, produced

According to accepted standards and format, provide an effective and efficient way to communicate specific information about design intent. Technical drawings are typically not open to interpretation like other drawings, such as decorative drawings and artistic paintings. A successful technical drawing describes a specific item in a way that the viewer of the drawing understands completely and without misinterpretation. The term technical drawing is also known as drafting, engineering drawing, mechanical drawing, mechanical drafting, technical drawing, and technical drafting. Drafting is a graphic language using lines, symbols, and notes to describe objects for manufacture or construction. Most technical disciplines use drafting, including architecture, civil and electrical Technical, electronics, piping, manufacturing, and structural Technical. The term mechanical drafting has alternate meanings. The manufacturing industry uses mechanical drafting, with its name derived from mechanisms.

Technical drawings communicate a variety of concepts, such as Technical requirements, instructions, and proposals, to a variety of people, such as the many different individuals often involved with a project. An Technical drawing or a complete set of Technical drawings provides all of the data required to manufacture or construct an item or product, such as a machine part, consumer product, or structure.

Technical drawing is used in many professions to draw (draft) ideas and different views of physical objects like drainages, culverts, septic tanks, incinerators, houses, etc. Drawing—either artistic or technical—is one of the oldest forms of communication, and is believed to be older than verbal communication.

Details of Technical SOPs:

- **Technical SOPs** detail how to perform and complete tasks. They are often in the form of a repeating work order, a preventative maintenance work order, or an inspection.
- **Management SOPs** detail how all other SOPs are created, updated, distributed, and overseen. This may sound silly, but companies often need SOPs to manage their SOPs. Essentially, management SOPs outline the processes and procedures to define, document, and implement standard operating procedures. This also means that management SOPs need to be checked and reviewed as often as technical SOPs. They can provide data on meeting safety and inspection standards and help manage the regular cycle of writing, approving, and revising the SOPs in use. Standard operating procedures' documentation is solid proof of quality assurance plans in action.

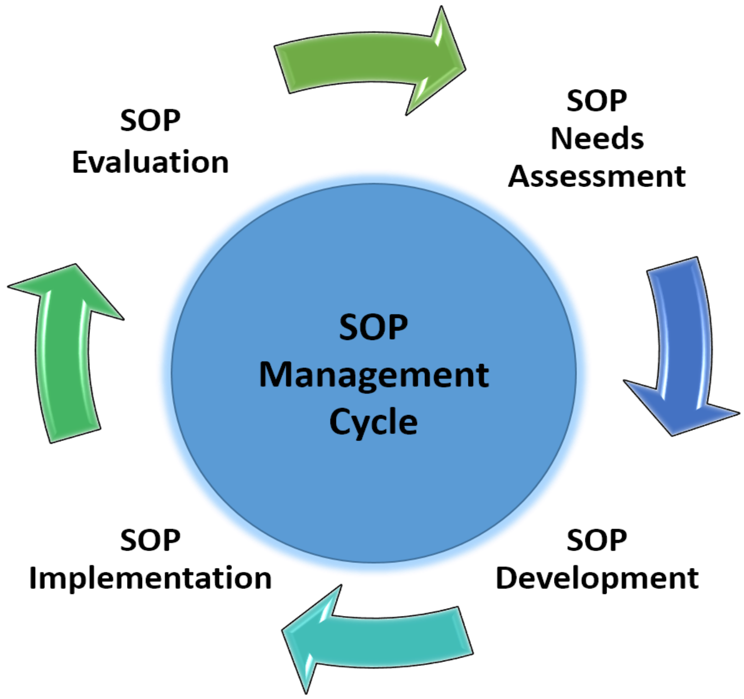


Figure 1.1 SOP management cycle

1.2 Work Health and Safety (WHS) Requirements

OH&S policies and procedures for installing and terminating wiring system means follow the correct occupational health safety procedures for safe individual, work area, Tools and equipment from electrical damage. The material that is used to protect individual safety against a risk to health and safety is called PPE (personal protective equipment). Always be aware that work items such as squares, compasses, rulers, and bevel are clean because they are the elements that will be in contact with the surface of the drawings.

Safety in the workshops is subject to a number of various risk assessments and safe codes of working practices which have to be observed and adhered to by all workshop users and enforced by the person in charge of these areas. Due to high-risk activities taking place in the workshops access to these areas is restricted to authorized personnel only. No other person may enter the workshops without permission.

OHS requirements are followed in accordance with safety plans and policies. Plant**,** tools and equipment selected to carry out tasks are consistent with the requirements of the job, checked for serviceability and any faults are rectified or reported prior to commencement. Before start using of the following equipment and tools check;

- Check the sharpness of pencil.
- Check the condition of drawing board or drawing table
- Check and clean drawing templates
- Check the compass etc

1.2.1 Work and health safety standards in technical drawing

Safety in technical drawing is related with ergonomics chair and table of drawing instrument, eyes problem due to long time working of drawing, sharp drawing instruments such as compass and divider, and body stresses while sitting for a long time, etc. The other safety concern related with the drafting room. The class needs sufficient natural and electric light for visibility of the drawing. Some of the safety related in the drawing class are listed below.

- ✓ Familiarize yourself with substances that are dangerous.
- ✓ Hands should be kept clean at all times during work.
- ✓ Wash your hands thoroughly after working with baby oil, soap and water,
- ✓ Keep the work area clean and try to keep it in order.
- ✓ Ask your doctor if you are taking medication or are pregnant about what precautions you should take with regard to work tools such as ink, which can in some way affect health.
- ✓ All drawing instruments should be kept clean with a cloth or towel.
- ✓ Identify the location of the extinguishers and the first aid box.
- ✓ Notify your boss of any health conditions or medications that may affect your work.
- ✓ Always have adequate ventilation.
- ✓ Hazards: Drawing inks are generally water based but there are some solvents that generally contain solvents such as xylene so precautions should be taken.
- ✓ Try to always keep the eraser free of ink and graphite.
- ✓ Have a brush to wipe away any debris from the eraser.
- ✓ Never deliver a project with small perforations caused by the use of the compass.

1.3 Job Requirements from Specifications

Before attempting to begin drawing, the proper conditions must be prepared. To complete the design according to the criteria, it is crucial to have all the necessary materials ready, including the paper size, a selection of pencils, an eraser, and other drawing tools. To satisfy the standards, interpreting the drawing is crucial after gathering all the resources required to complete the job/drawing. Job description includes basic job-related data that is useful to advertise a specific job to relate with skills of professionals. It includes information such as job title, job location, reporting to and of employees, job summary, nature and objectives of a job, tasks and duties to be performed, based on drafting work.

1.3.1 Purposes of specifications

A specification is a detailed description of the goods and/or services required and forms part of an invitation to supply or invitation for expressions of interest document. The cost of a unit quantity of work is governed by its specification. A work is carried out according to its specification and the request of customer. Any change in specification changes the tendered rate. The necessity of specification is to verify and check the strength of materials for a work involved in a project. Specification is an essential contract document and is required for Arbitration or court cases. Specification is necessary to specify the equipment, tools and plants to be engaged for a work and thus enables to procure them beforehand. A professional specification include basic information including clear, concise requirements and functional and performance terms.

1.1 Concepts of Fit and Tolerances

Interpreting drawing needs to understand the concept of fits and tolerances to describe detail specifications on the drawing. Limits and fits are a set of guidelines used in mechanical Technical that govern the dimensions and tolerances of mated machined parts in order to accomplish the required ease of assembly and security after assembly.

Tolerance. The total amount of permitted variance in a size is referred to as tolerance. It is the distinction between the size's maximum and minimum limits. Tolerances can be divided into three categories. These are unilateral tolerance, bilateral tolerances and limit tolerance.

Table 1.1 Types of tolerances

Type of tolerance	Description
Unilateral tolerance	20 $^{+.000}_{-.008}$
Bilateral tolerance	20 ± .004
Limit tolerance	2.255 2.245

Figure 1.2 Types of tolerances

Fits. Fit refers to the relationship between two pieces that results from their different sizes prior to assembly. Fits categorized as clearance fit, interference fit and transition fit.

Clearance fit: The largest permissible diameter of the shaft is smaller than the diameter of the smallest hole.

Interference fit: The minimum permissible diameter of the shaft exceeds the maximum allowable diameter of the hole.

Transition fit: Occurs when two tolerance mating parts are sometimes and interference fit and sometimes clearance fit when assembled.

Limits. When machining, it is impossible to manufacture a number of pieces to an exact measurement. There will always be some difference in size. As a result limits are set. This means that what the machinist manufactures can differ from the proper size by the small amount stated by the Limits, and still be able to be used. The required size of the component, before the Limits are set, is called the **Basic Size or Nominal Size. Then the Upper Limit and the Lower Limit are set.**

- 22.00 mm …. Nominal size
- 22.02 mm… upper limit
- 21.97 mm…. lower limit

Allowance: An allowance is the intentional difference between the maximum material limits.

Basis of Fit System

Although, the tolerances can be arranged in many ways, the following two systems of fits are followed:

1) **Hole basis system** – Limits of the hole are kept constant and the limits of the shaft are varied so as to obtain various types of fits. From manufacturing point of view, it is preferable to use hole basis system as it results in considerable reduction in the tooling requirements. ISO - the lower deviation of the hole is zero. Size of the hole is constant; shaft size is varied to get the required size as shown Figure below.

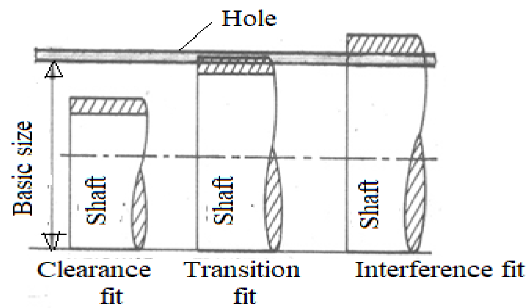


Figure 1.3 Hole basis system of fit

Shaft basis system

- Limits of the shaft are kept constant and the limits of the hole are varied so as to obtain various types of fits In some cases, shaft basis system is used:
  - When there are keys on the shaft
  - ISO - upper deviation of shaft is zero.

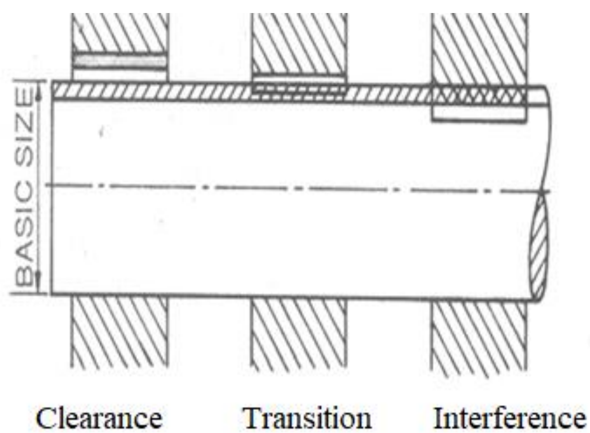


Figure 1.4 Shaft basis system

The standard designation of Fit

- Basic size followed by an alphabet **capital letter** representing “**hole**” & **small letter** representing: “**shaft**” and quality numbers. For example: 40H7/ g9 or 40H7 –g9

Alphabets represent the position of the tolerance zone with respect to (w.r.t) the basic dimension.

Limits and fits designation

- A hole tolerance with deviation **'H' and tolerance grade IT7 is designated 'H7'.**
- A shaft tolerance with deviation 'p' and tolerance grade IT6 is designated 'p6'.
- Appropriate tolerance designation for a feature of 45 mm, e.g. 45H7 or 45p6.

• A fit combines the basic size of both features and their designations. The designation of hole limits **should always be quoted first. E.g. 45H7-p6 or 45H7/p6.**

Self-check 1	Questions related to unit one.

Give short answer

1) What is the purpose of specification?
2) What is tolerance?
3) Explain about limit and fit.
4) What is the difference hole basis and shaft basis systems?
5) Interpret the reading of limit for 30H7-p5.

Unit Two: Identify views, standard symbols and lines

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying orthographic and isometric drawing
- Explaining orthographic and isometric views
- Identifying and using alphabet of lines
- Identifying and explaining angles of projection
- Identifying and explaining standard cods and symbols of drawing

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

- orthographic and isometric drawing
- orthographic and isometric views
- using alphabet of lines
- angles of projection
- standard cods and symbols of drawing

2.1 Alphabet of Lines

Lines in technical drawings are part of a specialized graphic language that is standardized throughout industry. Each type of line has a very precise symbolic meaning. Correct usage of this "alphabet of lines" is essential whether you use traditional drafting methods or CAD. Line weight is the thickness of the line. Manufacturinglines and guide lines are very light, easily erased lines used to block in the main layout. Visible lines are the edges or "outlines" of an object. They are drawn as solid lines with a thick/heavy weight.

Line	Appearance
Construction	
Visible/Object	
Hidden	
Center	
Dimension	
Extension	
Phantom	
Long Break	
Short Break	
Cutting-plane/ Viewing-plane	
Section	
Chain	

Figure 2.1 Types of alphabet of lines

1) Construction lines

Construction lines are used for laying out a drawing. Construction lines do not represent a specific drawing feature and are not reproduced on the final drawing. Use construction lines for all preliminary work. Construction lines are thin lines which can easily erase after construction of the desired object.

2) Visible Lines

Visible lines, also called object lines or outlines, describe the visible surface or edge of the object. Visible lines are drawn as thick lines as shown in Figure below. Thick lines are drawn .02 in. (0.6 mm) wide. Visible lines are usually drawn on a layer named something such as OBJECT and assigned a specific color, the visible line style, and the recommended thickness of .02 in. (0.6 mm).

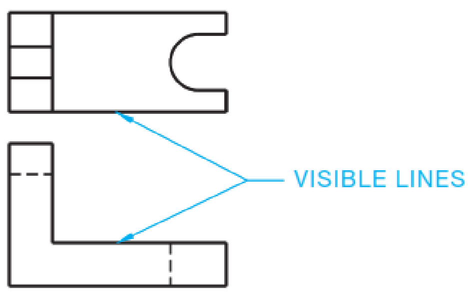


Figure 2.2 Visible lines

3) Hidden Lines

A hidden line represents an invisible edge on an object. Hidden lines are thin lines drawn .01 in. (0.3 mm) thick. Hidden lines are half as thick as object lines for contrast. Figure below shows hidden lines drawn with .125 in. (**3 mm) dashes** spaced .06 in. (1.5 mm) apart. This example represents the uniformity and proportions desired in hidden lines. However, the length and spacing of dashes can vary slightly in relation to the drawing scale. All hidden lines on a drawing should have the same dash length and spacing for uniformity.

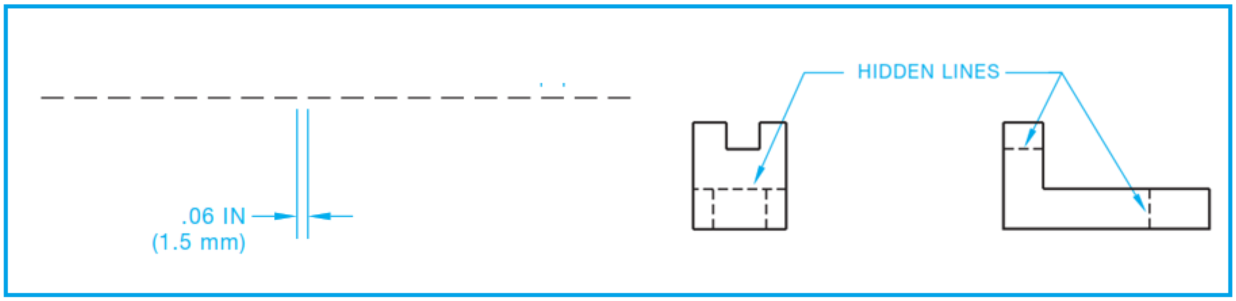


Figure 2.3 Hidden lines

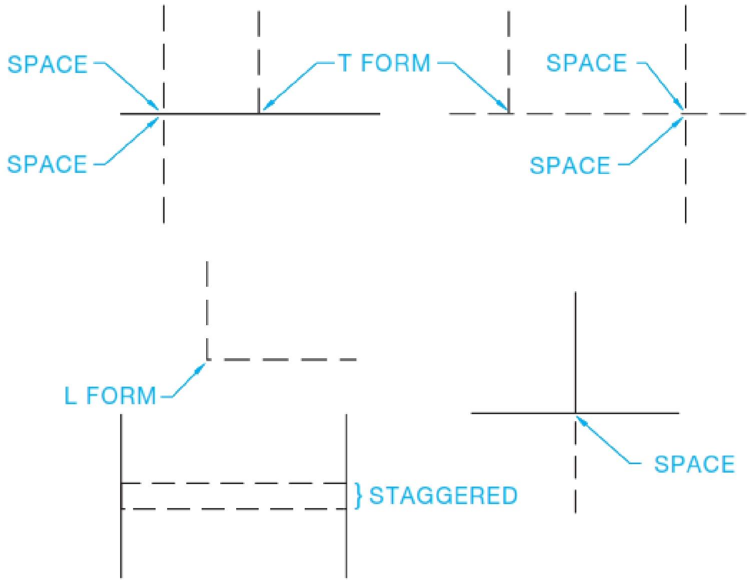


Figure 2.4 Hidden line rules

4) Centerlines

Centerlines are used to show and locate the centers of circles and arcs and to represent the center axis of a circular or symmetrical form. Centerlines are also used to show the centers in a bolt circle pattern or the paths of motion in a mechanism. Centerlines are thin lines on a drawing with the recommended thickness of .01 in. (0.3 mm). Centerlines are half as thick as object lines for contrast. Centerlines are drawn using a series of alternating long and short dashes. Generally, the long dash is about .75 to 1.50 in. (**19–35 mm**). The spaces between dashes are about .062 in. (**1.5 mm**) and the short dash about .125 in. (**3 mm**) long.

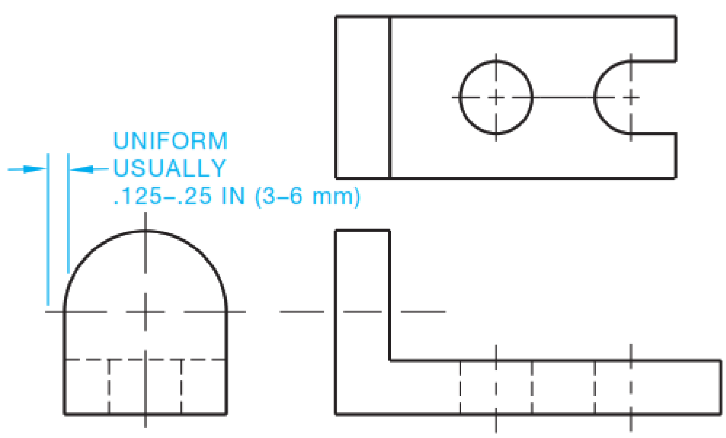


Figure 2.5 center lines

5) **Extension and dimension Lines**

Extension lines are thin lines used to establish the extent of a dimension as shown in Figure below. Extension lines can also be used to show the extension of a surface to a theoretical intersection as shown in Figure below. Extension lines begin with a .06 in. (1.5 mm) space from the object and extend to about .125 in. (3 mm) beyond the last dimension. Extension lines can cross object lines, centerlines,

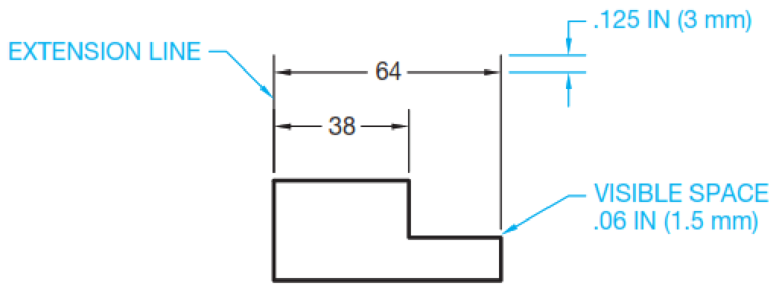


Figure 2.6 Extension and dimension lines

6) **Leader line** Leader lines, or leaders, are thin lines used to connect a specific note to a feature as shown in Figure below. Leader lines are also used to direct dimensions, symbols, item numbers, and part numbers on a drawing. Leaders can be drawn at any angle, but 45°, 30°, and 60° lines are most common. Slopes greater than 75° or less than 15° from horizontal should be avoided. Leader has arrow head which are used to terminate dimension lines and leader lines and on cutting-plane lines and viewing-plane lines described later. Properly drawn arrowheads should be three times. As long as they are wide. (3l: 1W ratio).

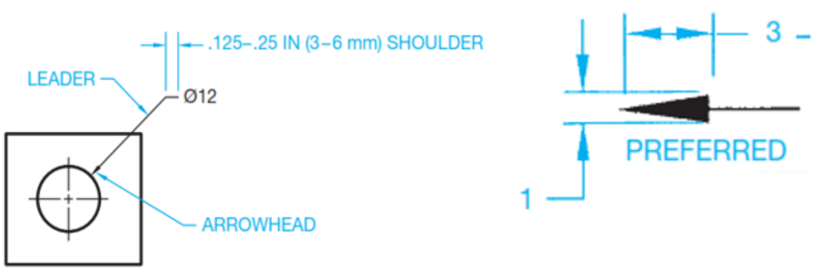


Figure 2.7 Leader line with its arrow head

7) **Cutting plane or section lines**

Cutting-plane lines are thick lines used to identify where a sectional view is taken. Viewing-plane lines are also thick and used to identify where a view is taken for view enlargements, removed views, or partial views. The cutting-plane line takes precedence over the centerline when used in the place of a centerline.

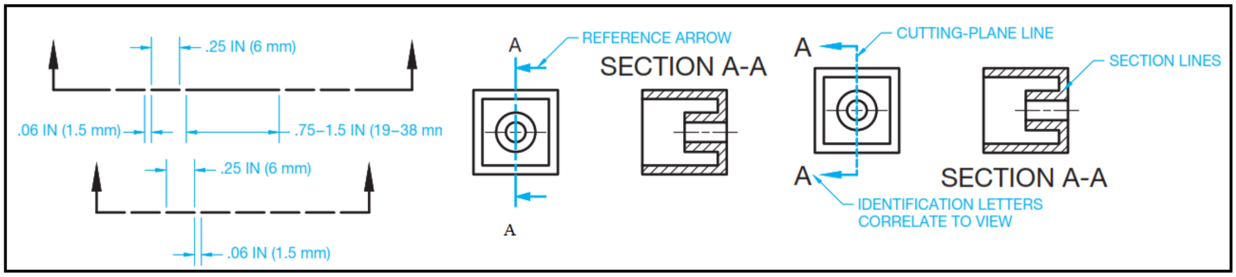


Figure 2.8 Section/cutting plane lines

8) **Section lines**

Section lines are thin lines used in the view of a section to show where the cutting-plane line has cut through material (see Figure below). Section lines are optional but generally used to show the material being cut by the cutting plane. Section lines are drawn equally spaced at 45°, but they cannot be parallel or perpendicular to any line of the object. Any convenient angle can be used to avoid placing section lines parallel or perpendicular to other lines of the object. Section lines placed at 30° and 60° are common

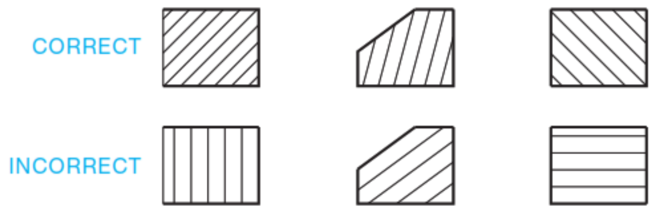


Figure 2.9 Correct and incorrect drawn section lines

For very large part, in can be represent the section lines as follow.

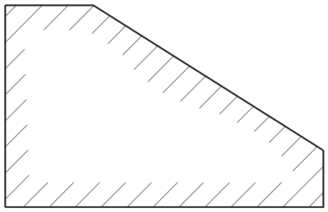


Figure 2.10 Outline section lines

There are different section lines for different materials.

Lettering

The description of an object or machine component requires the use of graphic language to show the shape and the written language to explain sizes and other information. The written language used on drawings is in the form of lettering. Freehand lettering, perfectly legible and quickly made, is an important part of engineering drawings. The ability to letter well and rapidly can be gained by constant and careful practice. The forms and preparations of each of the letters must be mastered by study and practice. Particular attention should be given to numerals as they form a very important part of every working drawing.

Lettering on Technical Drawings

The standardized lettering format was developed as a modified form of the Gothic letter font. The term font refers to a complete assortment of any one size and style of letters. The simplified cation of the Gothic letters resulted in elements for each letter that became known as single-stroke Gothic lettering. The name sounds complex, but it is not. The term single stroke comes from the fact that each letter is made up of a single straight- or curved-line element that makes lettering easy to draw and clear to read. There is upper-and lowercase, vertical, and inclined Gothic letters, but industry has become accustomed to using vertical uppercase letters as the standard.

Information on drawings that cannot be represented graphically by lines can be presented by lettered dimensions, notes, and titles. Lettering refers to all letters and numbers on drawings and related documents. It is extremely important for these lettered items to be exact, reliable, and entirely legible in order for the reader to have confidence in them and have no doubt as to their meaning. This is especially important when using reproduction techniques that require a drawing to be reduced in size using photocopy or microfilm.

The first step of writing letters is to study the shapes and proportions of the individual letters and the order in which the strokes are made. Guidelines drawn lightly with a sharp pencil should always be drawn for both the top and bottom of each line of letters. The semi-arrows and numbers give the order and direction of the strokes. Vertical strokes are always made from top to bottom,

Figure 2.11 Single-stroke vertical capitals and numerals

Drawing Papers

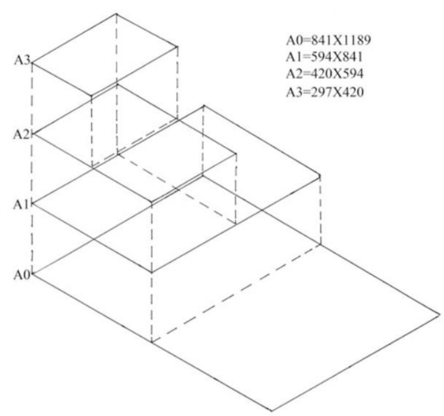
Drawing sheets of different sizes are available in the market. A good quality drawing is always made on a tough, strong, and glossy sheet with perfect white color. ASME Y14.1M, Metric Drawing Sheet Size and Format, specifies the following common metric drawing sheet sizes. The M in the title of the document Y14.1M means all specifications are given in metric.

Papers: Each smaller size has an area half of the preceding size, and the length to width ratio remains constant. (A0, A1, A2, A3, A4).

Types of drawing papers: - There are two classes of papers.

<u>A. Detail paper:</u> It is primarily for pencil work that is not used in reproduction processes that require a degree of transparency of the paper.

<u>B. Translucent paper also known as tracing paper</u>: which is designed so that it can be used in common reproduction process.



Size Designation	Size in Millimeters	
	Vertical	Horizontal
A0	841	1189
A1	594	841
A2	420	594
A3	297	420
A4	210	297

Figure 2.12. Different sizes of drawing sheets

Drawing Scale

A scale is an instrument with a system of ordered marks at fixed intervals used as a reference standard in measurement. A scale establishes a proportion used in determining the dimensional relationship of an actual object to the representation of the same object on a drawing. Drawings are scaled so that the objects represented can be illustrated clearly on standard sizes of paper. It would be difficult, for example, to make a full-size drawing of a house. You must decrease the displayed size, or scale, of the house to fit properly on a sheet. Another example is a very small machine part that requires you to increase the drawing scale to show necessary detail. Machine parts are often drawn full size or even two, four, or ten times larger than full size, depending on the actual size of the part. A drawing that shows a real object with accurate sizes reduced or enlarged by a certain amount. **The scale** is a ratio of the **size of the drawing to the size of the original object being drawn**. This may be referred to as a scale ratio. For example, if the scale is 1 cm: 3 cm, then the length of 1 cm in the drawing represents 3 cm in true size (or original size).

The selected scale depends on:

• The actual size of the objects drawn.

• The amount of detail to show.

• The media size.

• The amount of dimensioning and notes required

Metric Scales

- Full scale: 1:1
- Half scale: 1:2
- One fifth scale: 1:5
- One twenty-fifth scale: 1:25
- One thirty-three scale: 1:33
- One seventy-fifth scale: 1:75

Setting Up Paper on A Drawing Board

Drawing paper must be set up on a drawing board using a T-square. Once in position, the paper is clipped to the board with board clips or masking tape.

1. The T-square must be placed up against the edge of the drawing board. There must be no gaps . Otherwise the paper will not be set up correctly and drawing accurate horizontal and vertical lines will be impossible.

2. The paper is then allowed to rest on the T-square. Check that the paper rests properly on the T-square and that there are no gaps between the T-square and the paper or the T-square and the side of the drawing board. The clips can then be positioned holding the paper securely to the board.

3. A 2H pencil can then be used to draw faint horizontal lines across the page. Try to keep the lines to the same size by measuring them with a ruler. Each time you draw a line check that the T-square is pressed completely against the edge of the board. There should be no gaps.
4. To draw vertical lines a T-square and set -square are used together. Be careful to check that there no gaps between the T-square and the board and the set- square and the T-square.

Borderlines

The border is the format margin of a sheet, usually between the edges of the sheet to borderlines. The borderlines form a rectangle to establish the border. Distinct from the blank margins common on documents, a drawing border for standard size sheets can include zoning, a margin drawing number block, and microfilm alignment arrows. The ASME minimum distance from the edges of the sheet to borderlines, which forms the format margins is 20 mm for A0-and A1-size sheets; and **10 mm** for A2-, A3-, and A4-size sheets. For the purpose of binding, the left margin is greater than the other three margins (see Figure below).

Drawing A Border and Title Block

Title block. A title block provides a variety of information about a drawing, such as the title of the drawing, sheet size, and predominant scale, as described later in this chapter. ASME standards recommend placing the tile block in the lower right corner of sheet borderlines. The title block is different from company to company or university to university but commonly it contains. In every engineering drawing, a Title Block is included at the bottom right-hand corner. The Title Blocks are locally standardized but should be designed in such a way that it can be easily understood

- Name of the organization
- Drawn by
- Checked by
- Projection symbol
- Scale
- date
- Drawing numbers, etc.

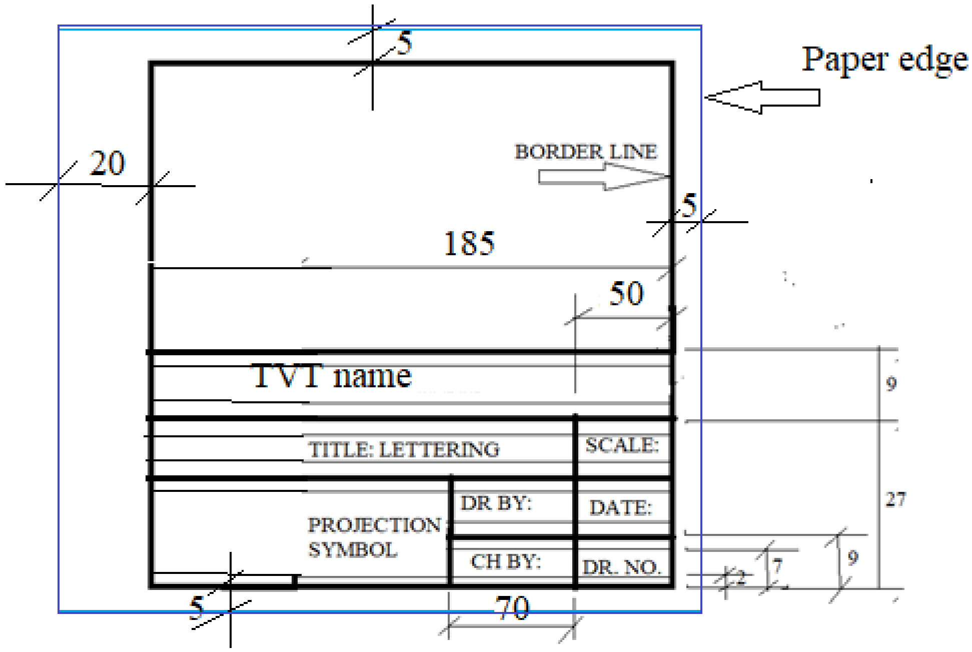


Figure 2.13 Typical Borderline and title block

2.2 Orthographic and Isometric Drawing

What is difference between isometric and orthographic? Isometric: a method of representing three-dimensional objects on a flat surface by means of a drawing that shows three planes of the object. Orthographic: a method for representing a three-dimensional object by means of several views from various planes.

Orthographic drawing is the projection of a single view of an object (such as a view of the front) onto a drawing surface in which the lines of projection are perpendicular to the drawing surface. Is it the representation of related views of an object as if they were all in the same plane and projected by orthographic projection. Although six different sides can be drawn, usually three views of a drawing give enough information to make a three-dimensional object. These views are known as front view, top view and end view. Other names for these views include plan, elevation and section.

2.1.1 Orthographic projections

It is A 2D drawing or multi-views of an object. This is a graphical method used in engineering drawings. The word orthographic is derived from the Greek words **ortho**-*straight*, *rectangular* and **graphos**-*written, drawn*. A drawing of a structure or part thereof can be drawn using the following projection methods:

- There are two methods of drawing orthographic projections:

  1) first angle projection and 2) third angle projection

a) First Angle Projection

when the object is situated in First Quadrant, that is, in front of V.P and above H.P, the projections obtained on these planes is called First angle projection.

b) Third Angle Projection

In this, the object is situated in Third Quadrant. The Planes of projection lie between the object and the observer. The front view comes below the xy line and the top view about it.

They are based on right angle planes with defined separate spaces, or quadrants. Each quadrant could Obtain an object to be presented.

2.1.2 Relative Position of Views

An object in space may be imagined as surrounded by six mutually perpendicular planes. So, it is possible to obtain six different views by viewing the object along the six directions, normal to the six planes. Fig. below shows an object with the six possible directions to obtain the six different views which are designated as follows.

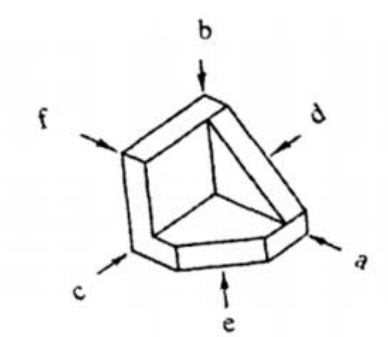


Figure 2.14 directions of views

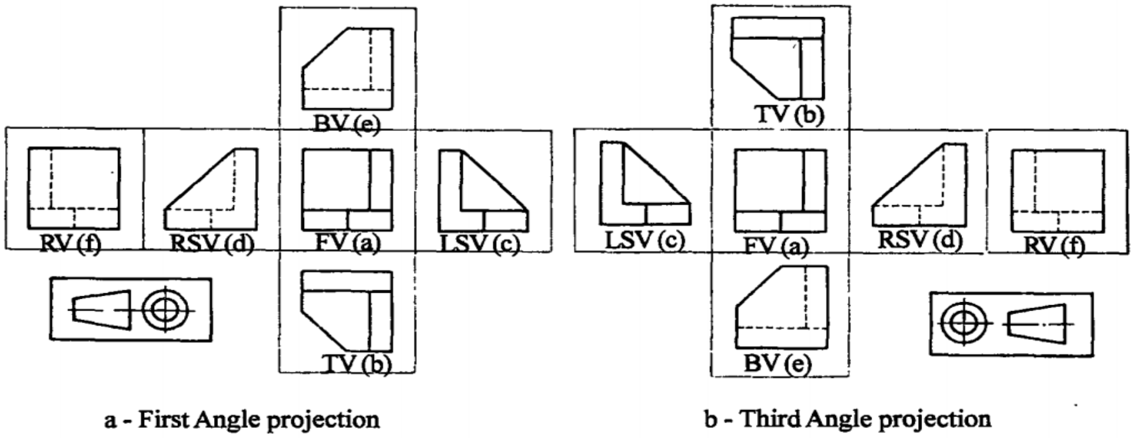


Figure 2.15 Relative Positions of Views

2.2.2 **Isometric Drawing**

The representation of isometric drawing is one of a family of three-dimensional views called pictorial drawings. In an isometric drawing, the object's vertical lines are drawn vertically, and the horizontal lines in the width and depth planes are shown at 30 degrees to the horizontal. When drawn under these guidelines, the lines parallel to these three axes are at their true scale) lengths. (Lines that are not parallel to these axes will not be of their true length. Any technical/engineering drawing should show everything: a complete understanding of the object should be possible from the drawing. If the isometric drawing can show all details and all dimensions on one drawing, when all three angles are equal the drawing is classified as a isometric.

In an isometric projection, all angles between the axonometric axes are equal. To produce an isometric projection, you orient the object so that its principal edges (or axes) make equal angles with the plane of projection and are therefore foreshortened equally. Oriented this way, the edges of a cube are projected so that they all measure the same and make equal angles (of 120°) known as isometric axes which are shown in Figure below.

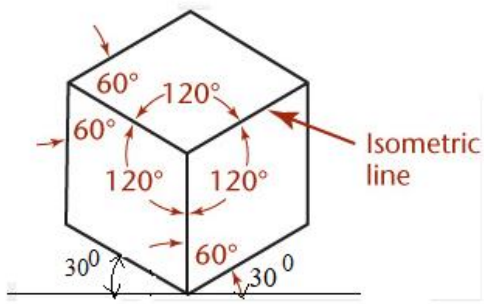


Fig 2.16. Isometric Drawing

Isometric drawing is a pictorial representation of an object in which all three dimensions are drawn at full scale. It looks like an isometric projection. In this case, all the lines parallel to its major axes are measurable. Looking at the front and back views, you can see that the object in question is shaped like an L. Looking at the right and left sides; you can discern how wide the object is. The top and bottom views show in which directions the legs of the L point. With this information and a little practice, you can determine that the three-dimensional object in question would look like the figure below.

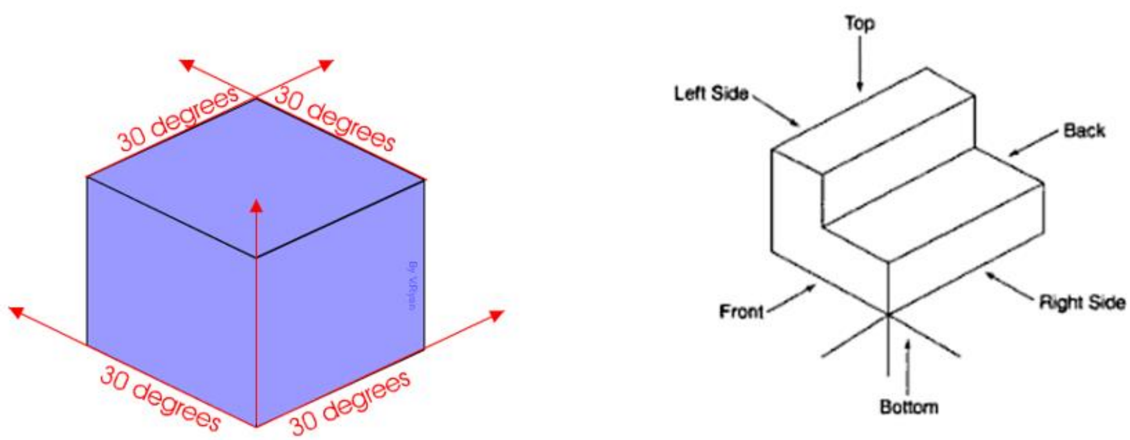
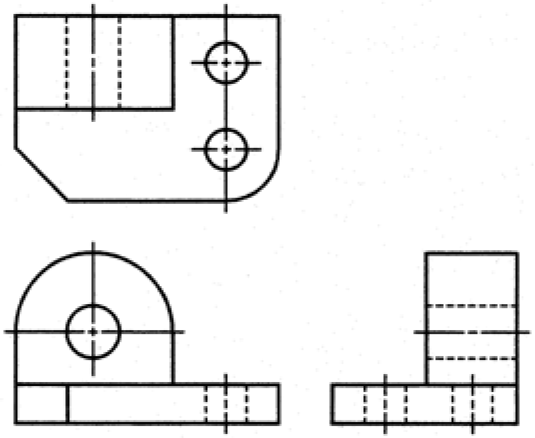
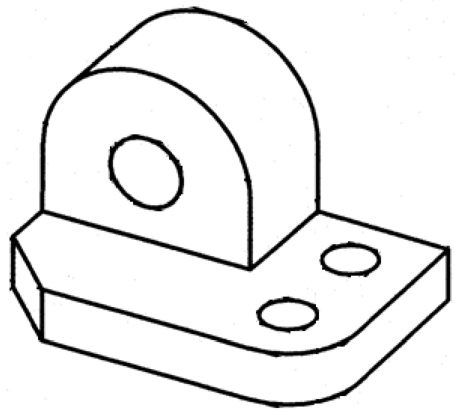


Figure 2.17 Three-dimensional view of an object

It's very important for a student to analyze the parts and elements of an object so that he can correctly form the final 3D appearance of the object base on the given views. In the case of producing a 3D object, two or three necessary views are needed. A 3D view being referred to this topic is the isometric view of an object. Examples of analyzing the given planar views (orthographic views) to form a 3D view (isometric view) are shown below:

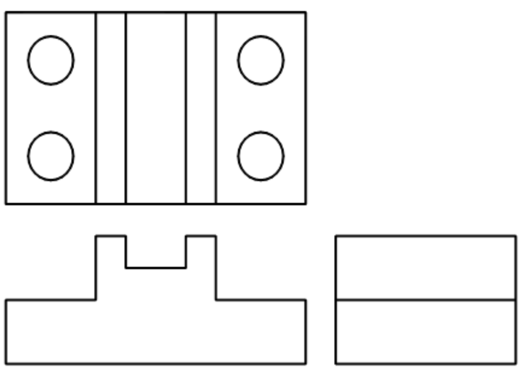
Example No. 1:

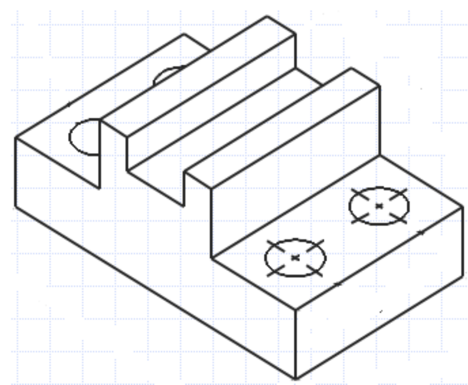




Given the 3 orthographic views The final view of the object

Example No. 2:





Given the 3 orthographic views The final view of the object

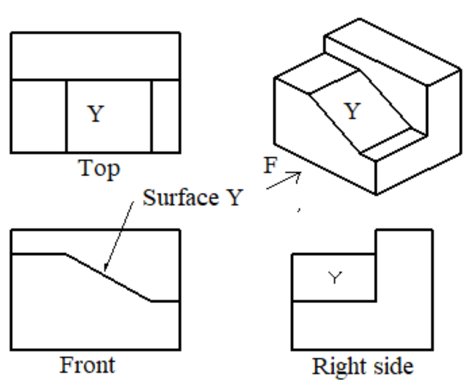


Figure 2.18 Multi-views and isometric drawing

Above are samples of how isometric views can be constructed from the three given orthographic views, on the other way, the three orthographic views can be constructed when an isometric view is given?

2.2 Orthographic and Isometric Views

Orthographic is a system of views of an object formed by projectors from the object perpendicular to the desired planes of projection. Orthographic Projections are a technical drawing in which different views of an object are projected on different reference planes observing perpendicular to respective reference plane.

Glass box method

The Glass Box Method, used primarily for descriptive geometry problems, requires that the user imagine that the object, points, lines, planes etc. are enclosed in a transparent "box". Each view of the object is established on its corresponding glass box surface by means of perpendicular projectors originating at each point of the object and extending to the related box surface. The box is hinged so that it can be unfolded on to one flat plane (the paper).

This method is used for the projection of mufti-views. The easiest way to explain the development of a orthographic drawing is to place an object in a glass cube as shown in the opposite figure. The object surfaces are then projected on the faces of the cube. The cube like any card box can be unfolded so that all six-surface shown as blow. The object is placed in a glass box, and the side of the box represent the 6 principal planes. Using the "glass box" method of visualization helps us understand the relationship views have with one another, i. e. the front view is next to the top and right side views, etc.

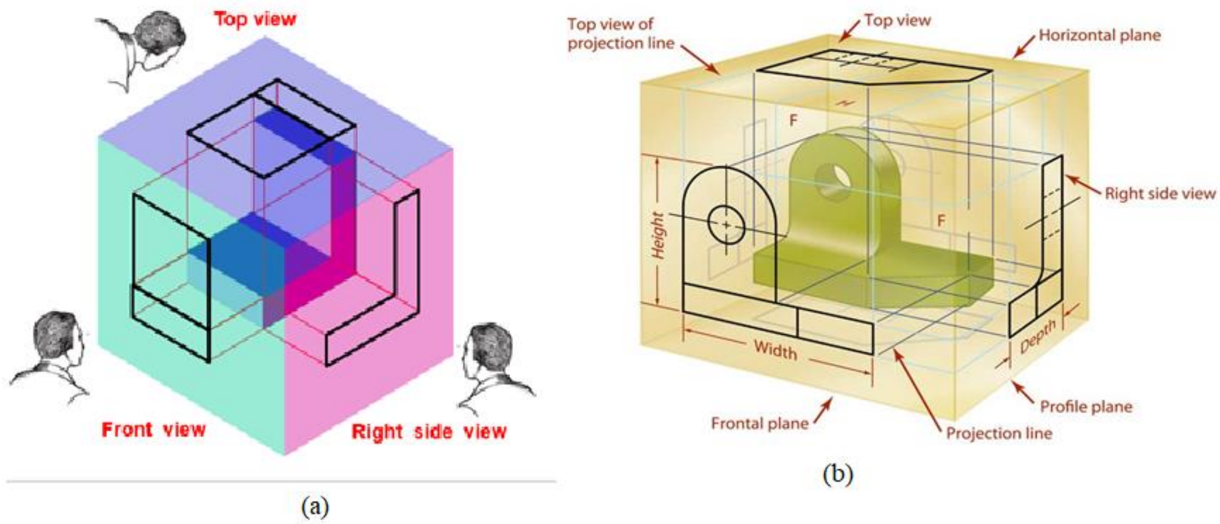


Figure 2.19 Views observing on in the Glass box

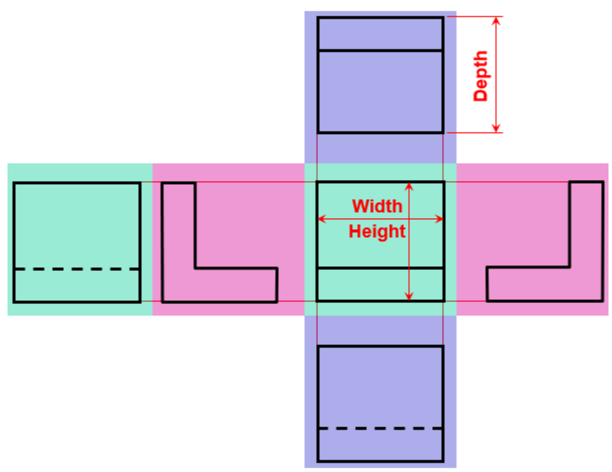


Figure 2.20 The six- views obtained from glass box

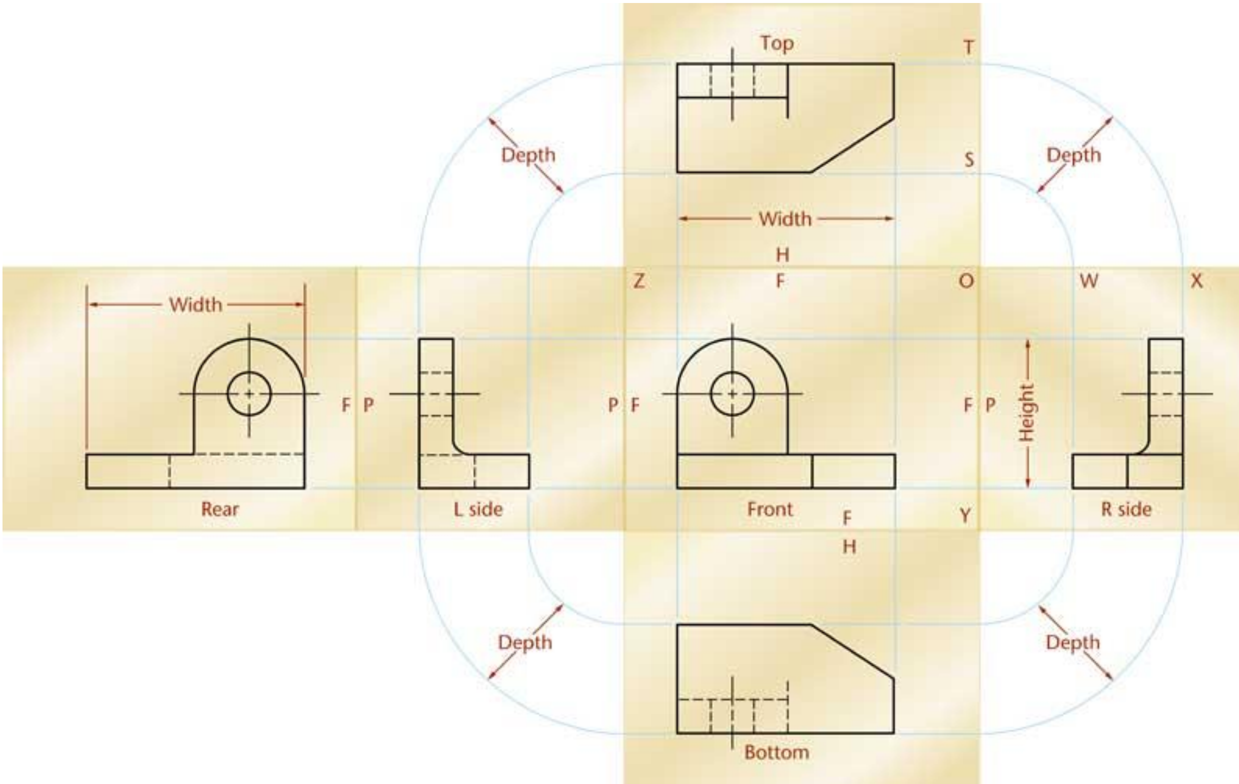


Figure. 2.21 Unfolding the glass box will show the six possible views of the object

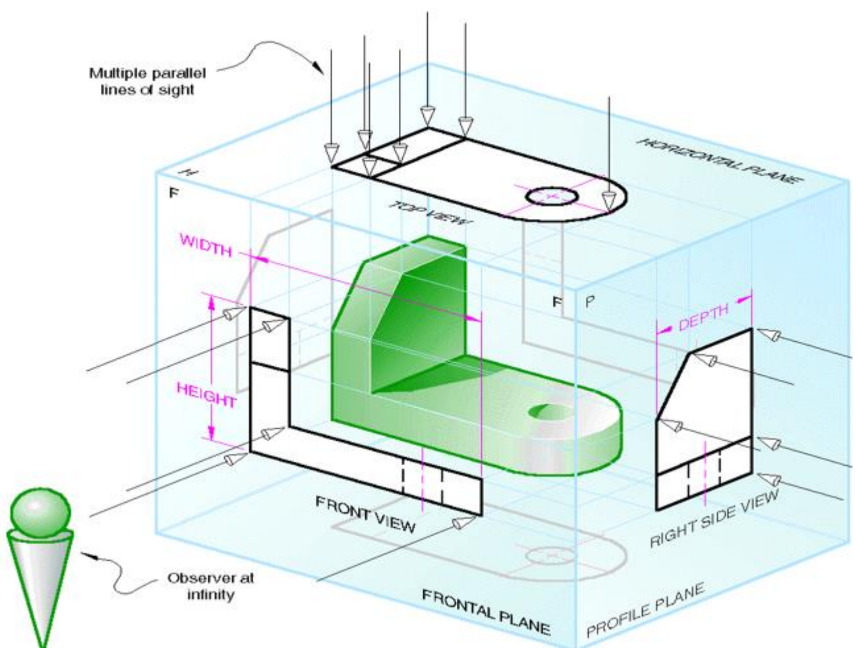


Figure 2.22 Projection planes with glass box

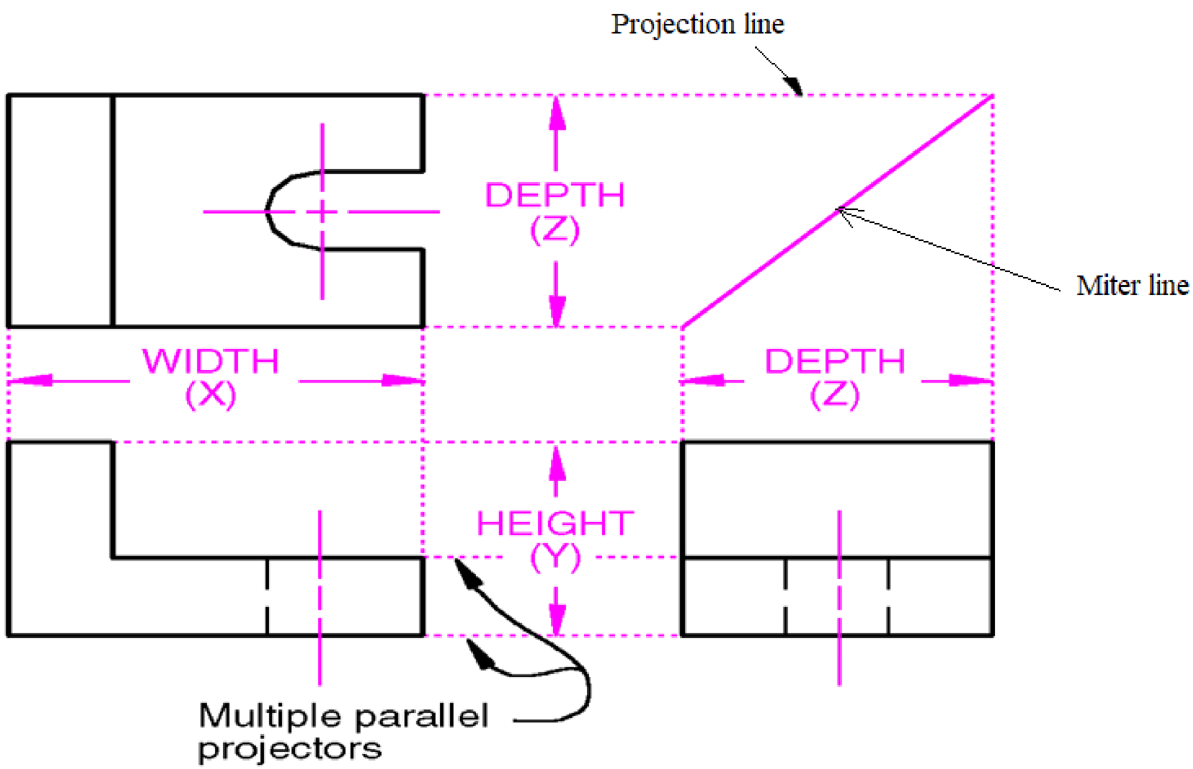


Figure 2.23 Drawing orthographic view technique

Isometric view

Isometric view/projections ~ a pictorial projection of a solid object on a plane surface drawn so that all vertical lines remain vertical and of true scale length, all horizontal lines are drawn at an angle of 30 degree and are of true scale length therefore scale measurements can be taken on the vertical and 30 lines but cannot be taken on any other inclined line.

A similar drawing can be produced using an angle of 45 degree for all horizontal lines and is called an Axonometric Projection.

2.3.2 Plane of projection

There are 3 Reference planes of projection:

- Horizontal Plane (HP) - in which the top view of an object is projected.
- Vertical Plane (VP) - in which the front view of an object is projected.
- Side or Profile Plane (PP) - in which the side view of an object is projected.

Different views are;

- ✓ Front View (FV) –Projected on VP

- ✓ Top View (TV) –Projected on HP
- ✓ Side View (SV) –Projected on PP

A projection is a drawing or representation of an entity on an imaginary plane or planes. It consists four components: The actual object that the drawing or projection represents. The eye of the viewer looking at the object. The imaginary projection plane (Viewers drawing paper Imaginary lines of sight called **projectors.** Two broad projection types are viable with different further classifications. These are:

- ✓ Parallel projection
- ✓ Perspective projection

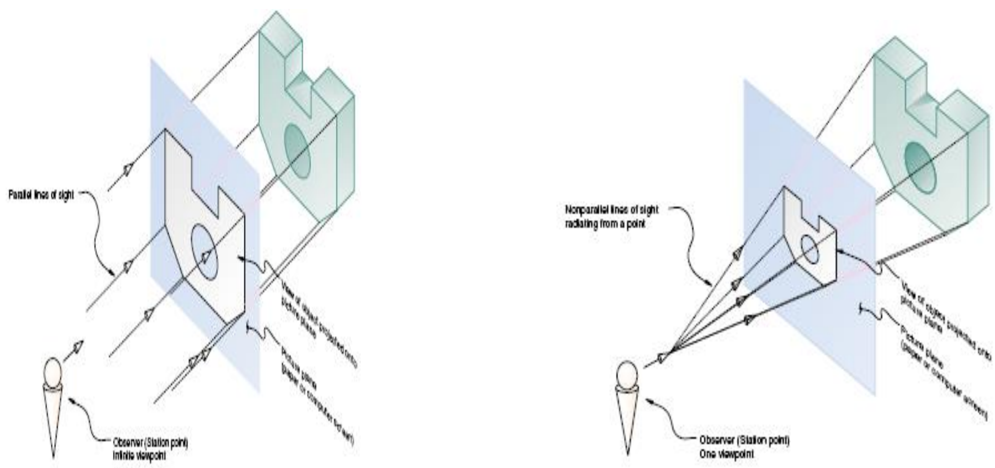


Figure 2.24 Type of projections (Parallel and perspective projection)

Parallel projection is a projection where imaginary projection lines will not converge as a point on the viewer’s eye. This implies that, all projection lines are either parallel or perpendicular to each other. There are three main types of parallel projection system illustrated below:

- ✓ Orthographic projection
- ✓ Axonometric projection.
- ✓ Oblique projections

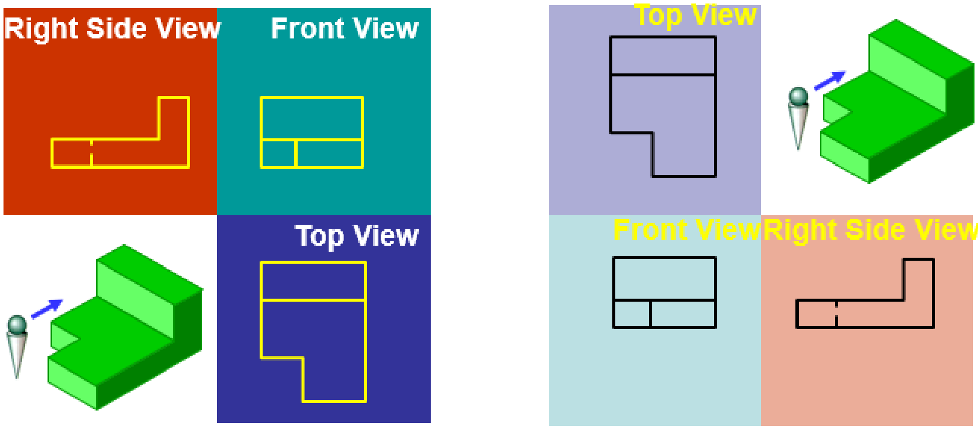


Figure 2.25 Multi-views in the first and third angle projections

2.3.4 The Six Principal Views

Let us surround the object entirely by asset of six planes, each at right angles to each other. On these planes, views of the object can be obtained as is seen from the top, front, and right side, left side, bottom and rear. Think now of the six sides, or the plane of the paper. The front is already in the plane of the paper, and the other sides are, as it were, hinged and rotated in position as shown.

Views possible in orthographic projection

A. Top
B. Bottom
C. Front
D. Rear
E. Right side
F. Left side

Principal views in orthographic projection

A. Top
B. Front
C. Right side

(**NOTE:** Other views such as auxiliary views can be used if needed to show features that are hidden in the principal views).

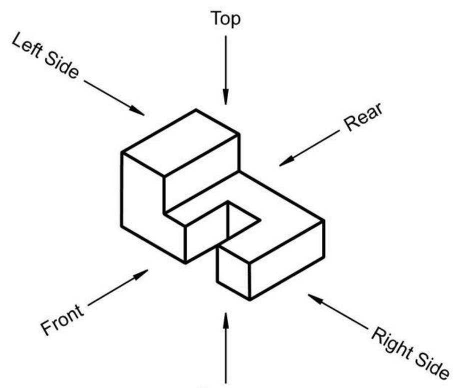


Figure 2.26 Orthographic views directions

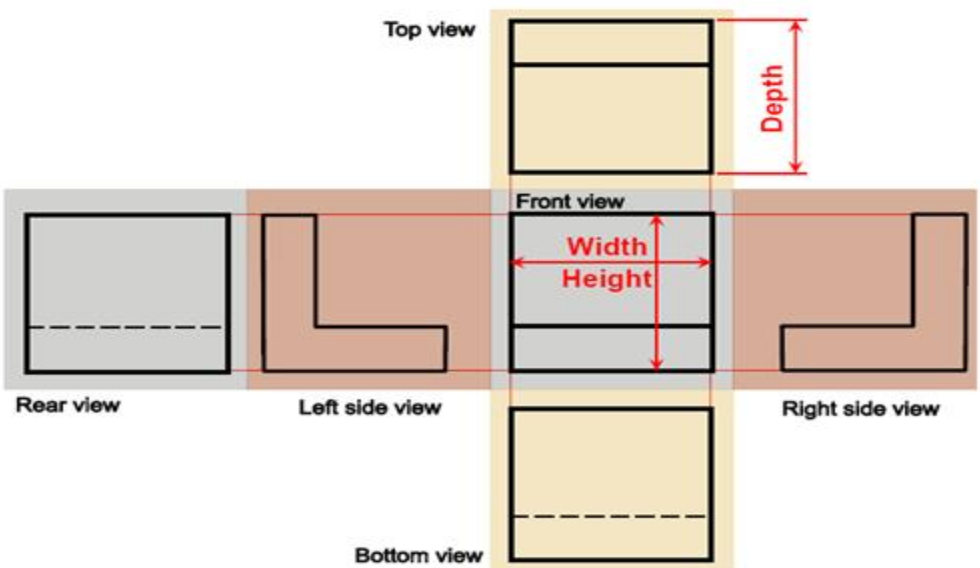


Figure 2.27 The six principal Views

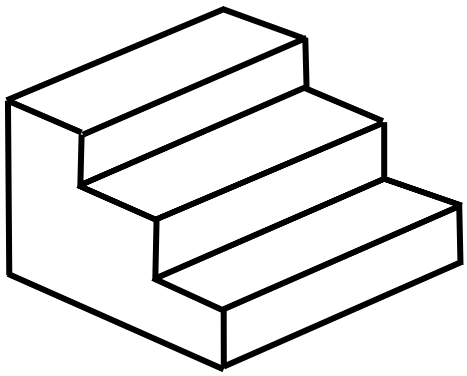
Selection of views

The number of orthographic 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 is drawn. While selecting the views; the object is placed in such a way the numbers of hidden lines are kept to minimum. 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 by arrows.

Steps in visualizing an orthographic projection

A. Visualize by looking at the actual object or picture of the object.

B. To obtain views, project the lines of sight to each plane of projection from all points on the object.
C. Rotate all planes until they align with frontal plane of projection.
D. Visualize the six possible views of the object that are revolved into the same planes on a drawing surface.
E. Inspect views and determine those needed to adequately represent the object



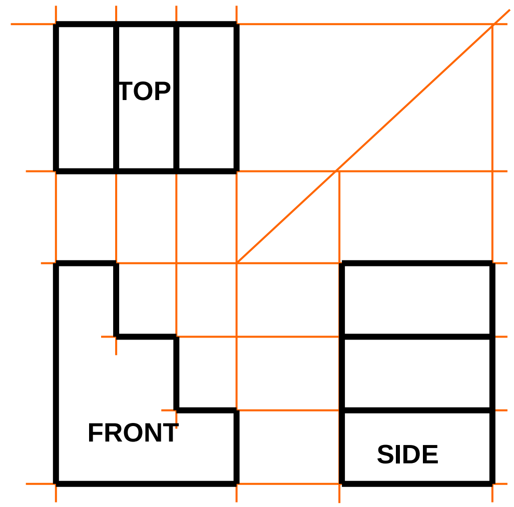


Figure 2.28 (Multi-view drawing)

2.4 Angles of Projection

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. First angle is mostly utilized in the European country - ISO standard

The First Angle Projection

Symbol:

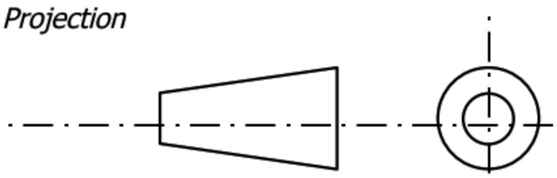


Figure 2.29 Symbol of first angle projection

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.

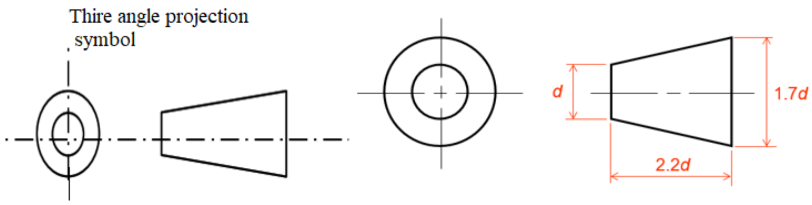


Figure 2.30 Proportions of projection symbol

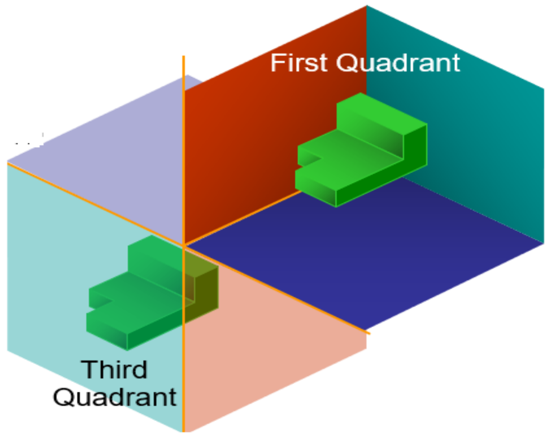


Figure 2.31 First and third angle projections positions

2.5 Standard Cods and Symbols of Drawing

Technical drawing has internationally agreed standards, codes and symbols. Some developed countries have their own standards while describing an object using drawing. Permit consistency in the way dimensions and tolerances are specified, and each symbol has a clearly defined meaning. Symbols take less time to apply on a drawing than would be required to state the same requirements with words. The symbols also require considerably less space. he symbols are presented in two groups for easier use of this section as a reference. General dimensioning symbols are shown first. Some of these symbols are also used in tolerance specifications. The second sets of symbols are used for tolerances. Symbols are not generally used in text or notes lists. Abbreviations and symbol names are used in text or notes.

2.5.1 Drawing standards/references

The following norms or standards shall principally apply when these drawing standards are used. In case of dated references, only the indicated edition shall apply; in case of undated references, the latest edition of the indicated document shall apply.

- DIN EN ISO 1101 Geometrical product specifications (GPS) - Geometrical tolerancing

– Tolerances of form, orientation, location and run-out

- DIN EN ISO 1302 Geometrical product specifications (GPS) – Indication of surface texture in technical product documentation
- DIN ISO 2768-1 General tolerances; Tolerances for linear and angular dimensions without individual tolerance indications
- DIN ISO 2768-2 General tolerances; Tolerances of form and location without individual tolerance indications
- DIN EN ISO 5459 Geometrical product specifications (GPS) - Geometrical tolerancing

  – Datum references and datum reference systems
- DIN EN ISO 8015 Geometrical product specifications (GPS) - Fundamentals - Concepts, principles and rules
- DIN EN ISO 10579 Geometrical product specifications (GPS) – Dimensioning and tolerancing – Non-rigid parts
- DIN ISO 13715

  Technical drawings – Work piece edges of undefined shape –

  Terminology and drawing information
- DIN EN ISO 14405-1 Geometrical product specifications (GPS) - Dimensional tolerancing

  - Part 1: Linear sizes
- DIN EN ISO 14405-2 Geometrical product specifications (GPS) – Dimensional tolerancing - Part 2: Dimensions other than linear sizes
- DIN EN ISO 14405-3 Geometrical product specifications (GPS) - Dimensional tolerancing

  - Part 3: Angular sizes
- DIN 30630

Technical drawings - General tolerances in mechanical engineering

– Tolerance rules and general plan

Table 2.1 Standard Code

Country	Code of standard	Description
USA	ANSI	**A**merican **N**ational **S**tandard **I**nstitute
Japan	JIS	**J**apanese **I**ndustrial **S**tandard
British (UK)	BS	**B**ritish **S**tandard
Australia	AS	**A**ustralian **S**tandard
German	DIN	**D**eutsches **I**nstitut für **N**ormung
	ISO	**I**nternational **S**tandards **O**rganization

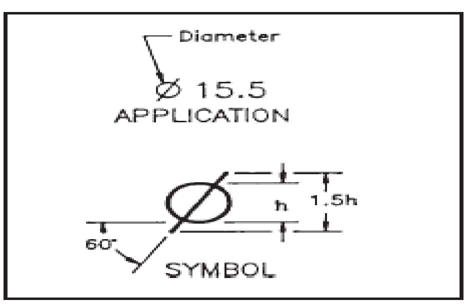
General symbols are used with dimensions to clarify the requirement defined by a dimension value and to minimize the number of words or abbreviations placed on a drawing.

Drawing Symbols

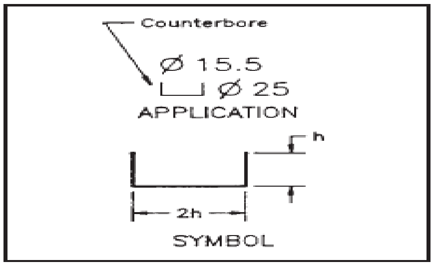
Permit consistency in the way dimensions and tolerances are specified, and each symbol has a clearly defined meaning. Symbols take less time to apply on a drawing than would be required to state the same requirements with words. The symbols also require considerably less space. The symbols are presented in two groups for easier use of this section as a reference. General dimensioning symbols are shown first. Some of these symbols are also used in tolerance specifications.

Examples

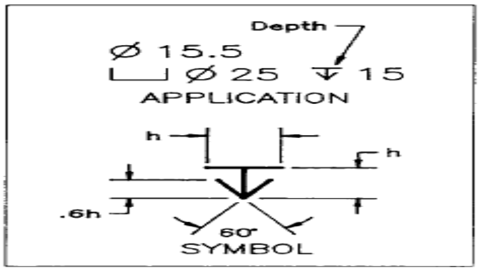
1. **Diameter**:- A diameter symbol is placed in front of any dimension value that is a diameter.



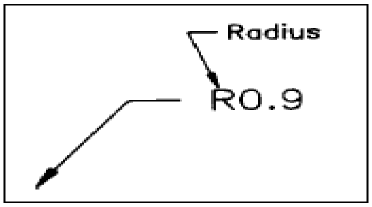
2. **Counter bore Symbol**: - A **counter bore** symbol combined with a diameter symbol is placed in front of a specified counter bore or spot face diameter.



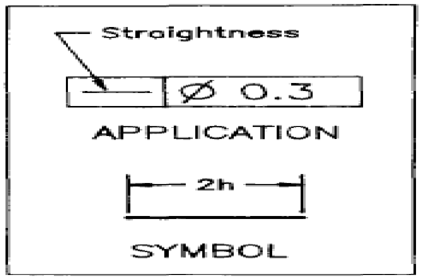
3. **Depth***:* - A downward-pointing arrow is used for the depth symbol, and it is placed in front of the depth value in such applications as for counter bore and hole depths.



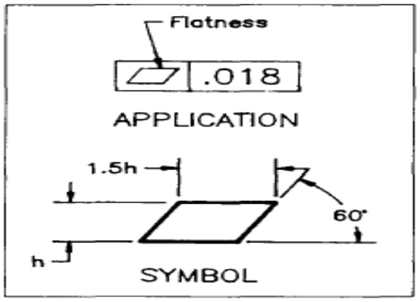
4. **Radius**: - The letter **R** is placed in front of any value that indicates a radius dimension.



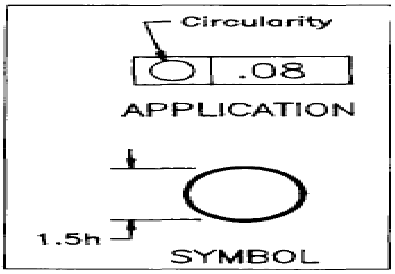
5. **Straightness**: - is used to indicate a Straightness requirement. It is only applied in a feature control frame, and maybe used to control straightness of surface elements. It may also be used to control the straightness of an axis or center plane.



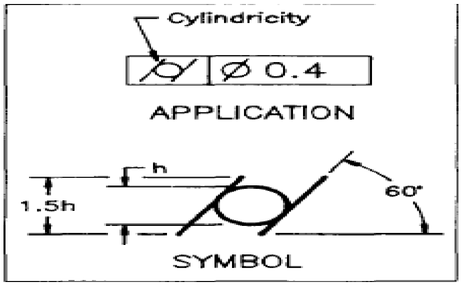
6. **Flatness**: - symbol appears as an oblique view of a square surface. This symbol is used in feature control frames and is only used to control the form variations on flat features.



7. **Circularity: -** is indicated by a circle. It controls the amount of form error permitted on the surface of a circular feature at individual cross sections.

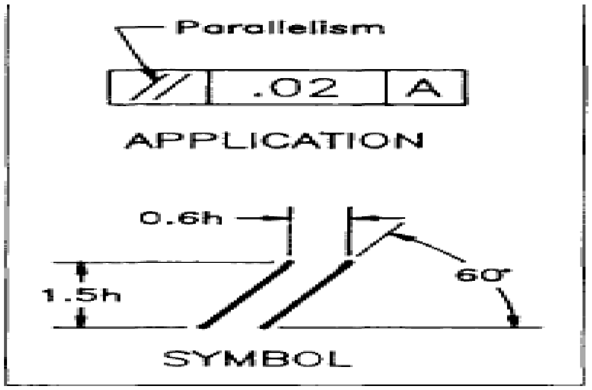


8. **Cylindricity**: - This symbol is a circle with two parallel lines drawn tangent to the circle. It is used to control the surface errors on a cylindrical feature. It simultaneously

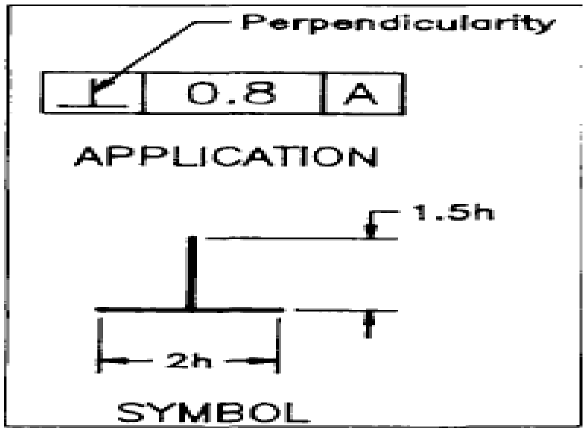


9. **Orientation -** Orientation **tolerance** symbols include **parallelism, perpendicularity,** and **angularity:**

    - ✓ **Parallelism**. Parallelism is indicated by two parallel straight line.



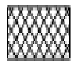
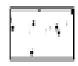
- ✓ **Perpendicularity** – Perpendicularity is indicated by two perpendicular lines



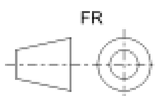
Self-check 2	Multiple choice

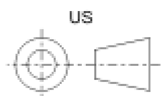
I. Choose the best answer

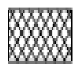
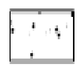
1. Which one of the following is the symbol of diameter?(2 points)

a) # B. Ø C.  **D.** 

2. One of the following is the symbol of third angel projection.

A. 

b. 

c.  **d.**  **E .all**

3. ________________is a line drawn around the inside edge of the paper.

A. board line C. drawing board

B. Title blocks D. All

4. _____________________is normally drawn at the bottom of the paper.

A. a title blocks C. drawing sheet

B. drawing space D. board line

5. One of the following views gives length and width of dimensions

A. side view C. Front view

B. top view D. none

6. Which one of a common standards used in orthographic projection of drawings

A. First Angle Projection B. European projection

C. Third Angle Projection D. all are answer

7. Which orthographic views principles are correct in making drawing In first angle projection

A. Front view on the above and the Top view at the bottom

B. front view and the side view are always in line horizontally

C. Front view is drawn seeing the object in a direction is which its length is seen.

D. All above answer are correct

8. __________is a kind of technical drawing instruments used to prepare drawings

A. set squares B. French curve

C. T-square D. all

9. Which one is used to mark or measure angles between 0 and 180

A. Protractor B. Divide

C. ellipse template D. Circle Template

10. ________is a thin, flat piece of plastic containing various cutouts shapes

A. Tamplate B. French curve set squares

C. T-square D. curve set squares

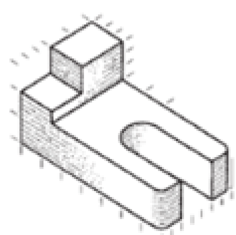
11. Which one of the following is the largest size of drawing sheets

A. A4 B. A0

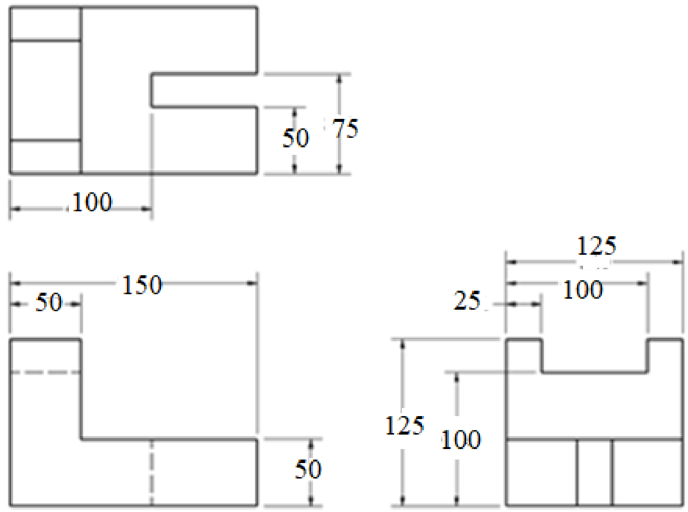
C. A5 D. all

III. Short Answer Questions

1. **Write and explain the difference between Orthographic views and Isometric drawing?**
2. What is the glass box concept all about?
3. How does the glass box approach concept aid the draftsman in producing orthographic views?
4. What are the 6 principal views involving in the glass box approach?
5. **Using the glass box approach, draw the three basic principal views of the objects below. Take dimensions by yourself.**



6. Given the figure of three orthographic views with corresponding dimensions below, sketch the isometric view.


50
75
100
125
150
50
25
100
125
100
50

Operation sheet 2.1	Lettering

Title: Lettering

Using Gothic lettering style write letters and numbers with (12 mm) high and space between lettering 5 mm apart.

Purpose: to write Gothic letters based on the context of technical drawing.

Materials required: A4 paper, pencils, Tape, etc.

Tools required: drawing equipment,

Procedure:

- Adjust drawing paper using set square and T-square.
- Fix the paper using tape
- Draw borderline and title block
- Prepare guidelines based on the height and width of letter.
- Write letters
- Keep clean your drawing.
- Return all drawing instruments and clean the work area.

Operation sheet 2.2	Isometric drawing

- **Operation title: - Procedure** how to draw isometric drawing.
- **Purpose:** To practice and demonstrate the knowledge and skill require **Procedure** how to identify and draw isometric drawing.
- **Instruction:** follow standard working procedures
- **Procedures in doing the task**

Step1. Set up the drawing paper on top of the drawing board.

Step2. Make parallel the edges of paper and the drawing board using T-square.

Step3. Properly secure the paper on top of the table by using masking tape or tacks or the likes.

Step4. Using the set of triangles and T-square, draw the border line around the drawing paper, leaving area for the title block at the bottom part.

Step5. Be sure to check the sharpness of your pencil lead. Use standard sharpening for good aesthetic result of your work.

Step6. For normal drafting or lettering use the soft lead pencil (**HB**) for final results. Use the harder lead pencil (**4H**) for guidelines drawing only.

Step7. Use the set of triangles, t-square and lead pencil this activity.

Step8. Always remember that construction lines and guidelines are necessary in sketching and drafting, so utilize this knowledge.

Step9. Apply the knowledge on line quality in your work and draw a box with isomeric lines.

Step10. Accuracy, neatness and aesthetics always go hand in hand with drafting, so do your work with quality.

Step11. You may submit your finish work once you are true but should be within the time specified for submission.

LAP Test 2.1	Practical Demonstration

Name: _____________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 4hours.

Task 1: Place the drawing paper on the drafting surface.

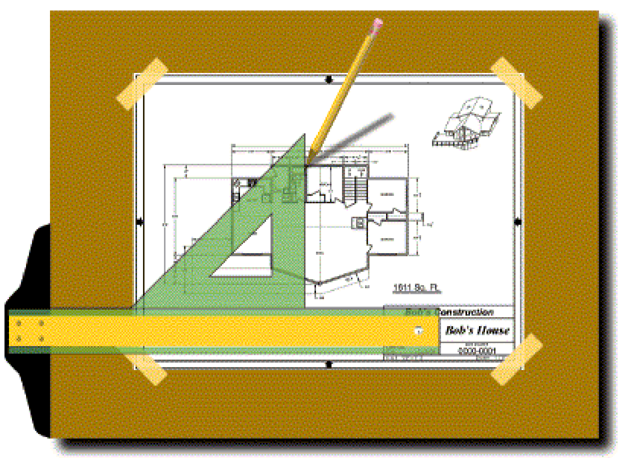
Task 2: Set the drafting machine at the "0" mark with parallel scale approximately horizontal to the drawing surface.

Task 3: Align the bottom edge of the drawing media with the parallel scale.

Task 4: Tape the drawing in place.

Task 5: Draw horizontal lines using the parallel scale as a guide

Task 6: Draw vertical lines by placing a triangle against the parallel scale and using the vertical 90° angle side of the triangle to trace along.



LAP Test 2.2	Practical Demonstration

Name: _______________________________ Date: _________________

Time started: _________________________ Time finished: _________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks with in **7** hour.

Task 1: Prepare drawing boarder line and title block

Task 2: draw free hand sketch drawing of box and cylinder with any dimensional size.

Task 3: draw orthographic projection drawing.

LAP Test 2.3	Practical Demonstration

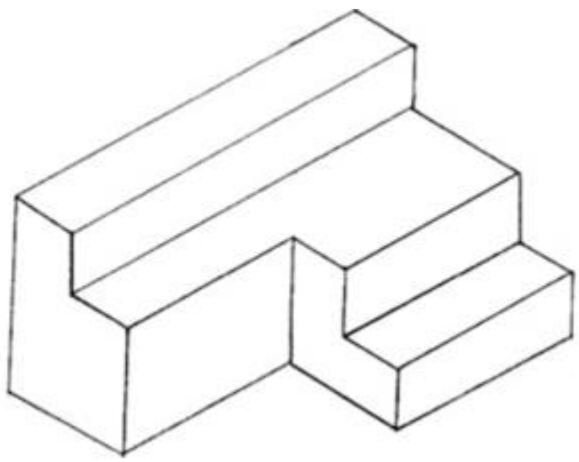
Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

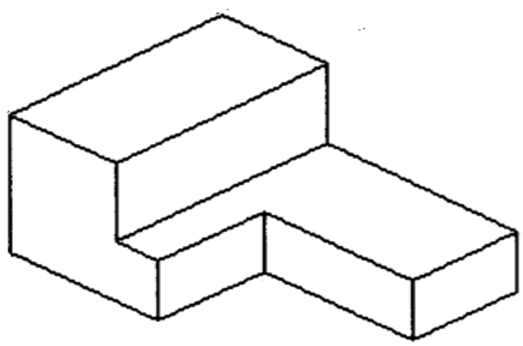
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 8 hours.

1. **You are required to do the following activities as required in the problem.**

Task 1: Draw the following drawing with the scale of 1:1. Take dimensions by direct measuring.



Task 2: Draw the one point perspective view of the isometric figure below.(one to one scale)



Unit Three: Prepare Technical Drawing

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Selecting appropriate manual drafting tools and equipment
- Drawing multi view drawings and product parts.

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

- select appropriate manual drafting tools and equipment
- draw multi view drawings and product parts.

3.1 Manual Drafting Tools and Equipment

Technical drawing instruments allow drafters to produce precise drawings. Technical drawing instruments are the tools used by professional and student drafters to render the precision graphics needed to manufacture a product or structure. These instruments take many forms because of the variety of lines and graphics needed for designs. Some instruments are manual, while others are computer-based. All professional quality drafting instruments are manufactured with precision because the drawings they're used to make must be precise.

i) Pencils

Automatic pencils are common for manual drafting, sketching, and other office uses. The term automatic pencil refers to a pencil with a lead chamber that advances the lead from the chamber to the writing tip by the push of a button or tab when a new piece of lead is needed. Automatic pencils hold leads of one width so you do not need to sharpen the lead. The pencils are available in several different lead sizes. Each pencil has a different grade of lead hardness and is appropriate for a specific technique. This reduces the need to change leads constantly. Some drafters use a light blue lead for layout work.

Figure 3.1 Automatic pencil

Lead grades

Lead grades of 2H and H are good in your automatic pencil for typical daily office use. The leads you select for line work and lettering depend on the amount of pressure you apply and other technique factors. Experiment until you identify the leads that give the best line quality. Leads commonly used for thick lines range from 2H to F, whereas leads for thin lines range from 4H to H, depending on individual preference. Construction lines for layout and guidelines are very lightly drawn with a 6H or 4H lead. Figure 2.3 shows the different lead grades.

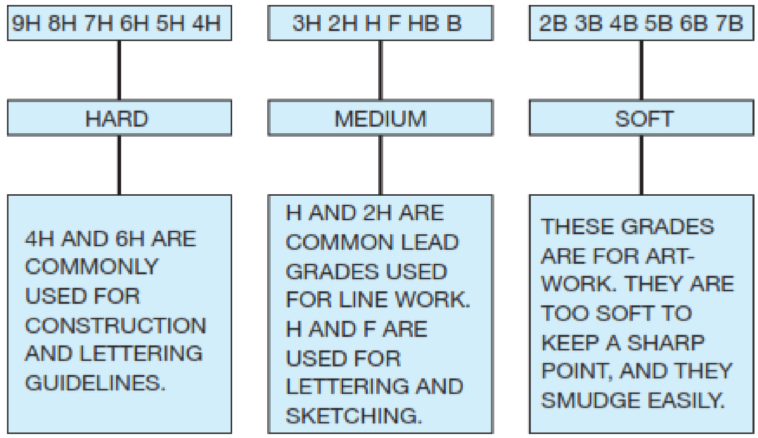


Figure 3.2 The range of lead grades

ii) Compass

A compass is an instrument used to draw circles and arcs. A compass is especially useful for large circles, but using one can be time-consuming. Use a template, whenever possible, to make circles or arcs more quickly. Professional manual drafting requires appropriate drafting equipment and supplies. You can purchase drafting supplies and equipment in a kit or buy items individually.

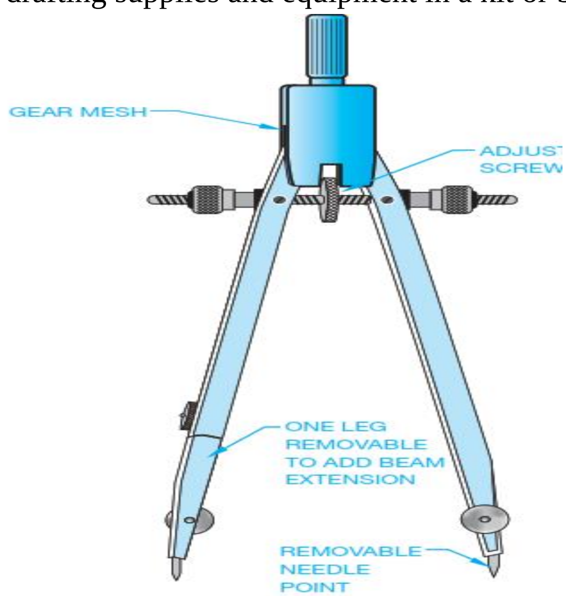


Figure 3.3 Compass

iii) Dividers

Dividers are used to transfer dimensions or to divide a distance into a number of equal parts. Dividers are also used in navigation to measure distance in nautical miles. Some drafters prefer to use bow dividers because the center wheel provides the ability to make fine adjustments easily. In addition, the setting remains more stable than with standard friction dividers.

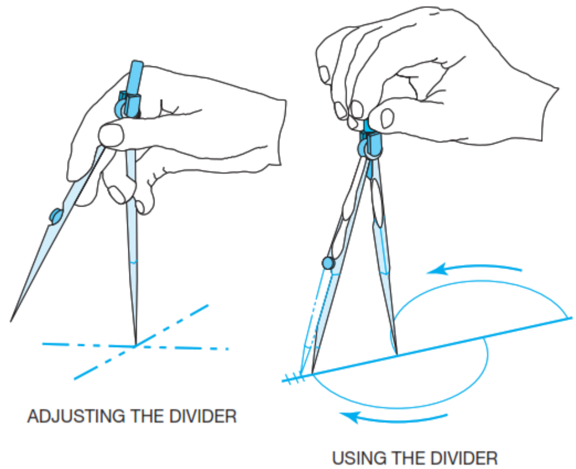


Figure 3.4. Using dividers

iv) Triangles (Set-squares)

There are two standard triangles. The 30º–60º triangle has angles of 308–608–908. The 458 triangle has angles of 458–458–908 (see Figure below). They are used to draw vertical and inclined parallel lines.

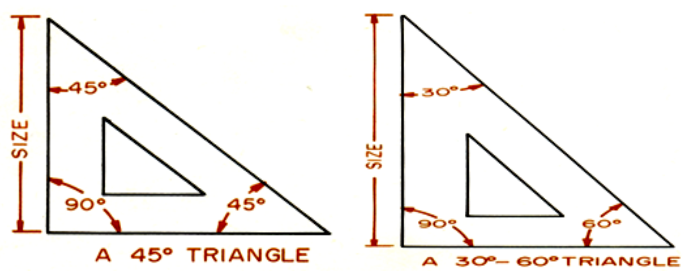


Figure 3.5. Set-squares (triangles)

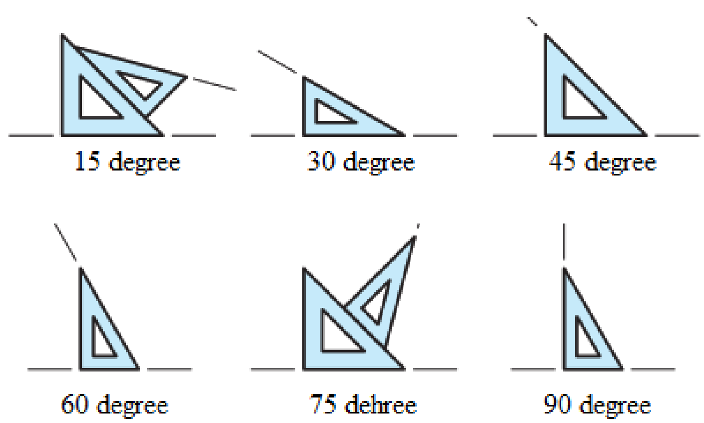


Figure 3.6. Usage of set-squares (triangles)

v) Templates

Manual drafting templates are plastic sheets with accurate shapes cut out for use as stencils to draw specific shapes. The most common manual drafting templates are circle templates for drawing circles and arcs. Templates for drawing other shapes, such as ellipses, and for letters are also common. Templates are also available for specific requirements and drafting disciplines. For example, use architectural templates to draw floor plans and other symbols to scale. Electronic drafting templates have schematic symbols for electronic schematic drawings. An ellipse is a circle seen at an angle. The figure 3.7b below shows the parts of an ellipse.

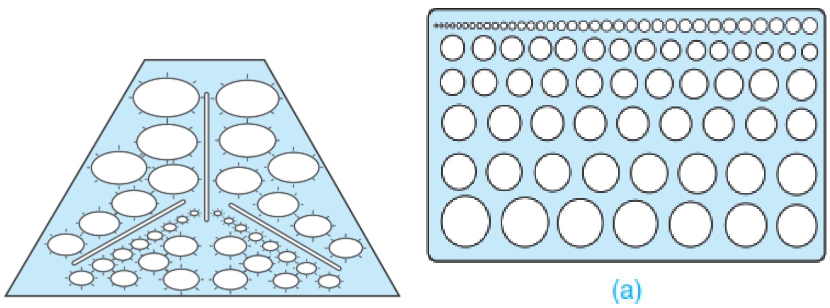


Figure 3.7. Templates: (a) circle and (b) ellipse

vi) French curve

Irregular curves, commonly called French curves, are curves that have no constant radii. Figure below shows common irregular curves. A radius curve is composed of a radius and a tangent. The radius on these curves is constant and ranges from 3 ft to 200 ft. (900–60,000 mm). Irregular Curves are commonly used in highway drafting. Ship's curves are also available for layout and the development of ships hulls.

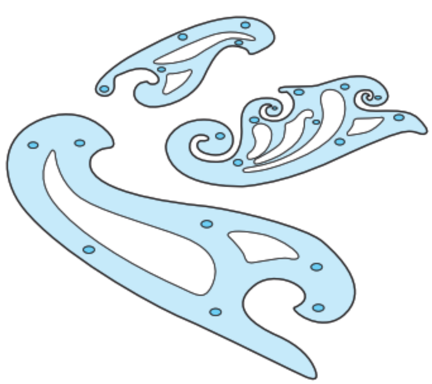


Figure 3.8. French curve

vii) T-Square

This is one of the oldest drawing instruments that still finds wide spread use both in the industry and in schools. It used to draw parallel lines. T-Squares are use to draw horizontal lines. They are especially useful when constructing accurate orthographic drawings or architectural drawings. A T-Square is normally used with a drawing board, set squares and clips.

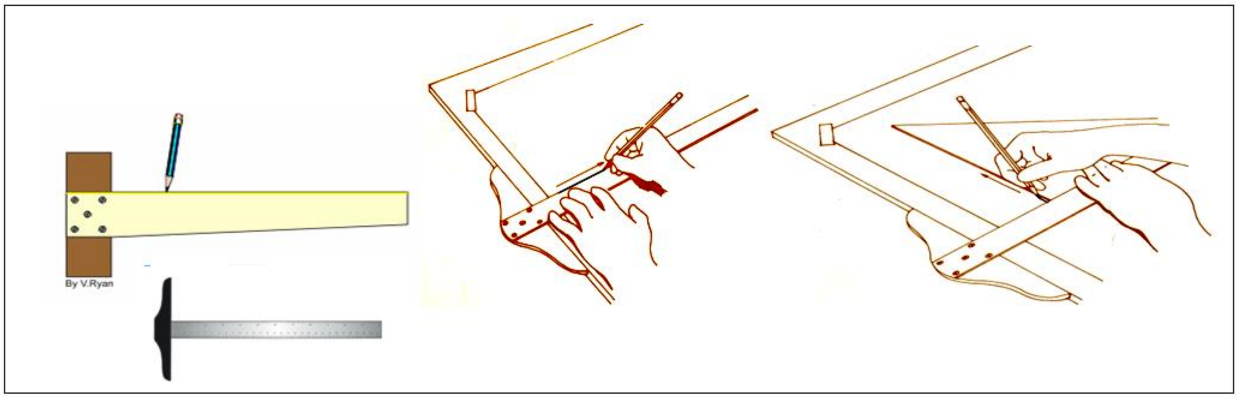


Figure 3.9 T-square

Drawing Board is Available in a variety of styles and sizes. Most are adjustable up and down, and can tilt to almost any angle from vertical 90º to horizontal. The drawing surface must be clean, flat, smooth, and large enough to accommodate the drawing and some drafting equipment. If a T-square is to be used, at least one edge on the board must be absolutely true. Most quality boards have a metal edge to ensure against warping and to hold the T-square securely.

Figure 3.10. Drawing Boards

Protractor used to mark or measure angles between 0 and 180°. They are semicircular in shape (of diameter 100mm) and are made of Plastic or celluloid which has more life. Protractors with circular shape capable of marking and measuring 0 to 360° are also available in the market.

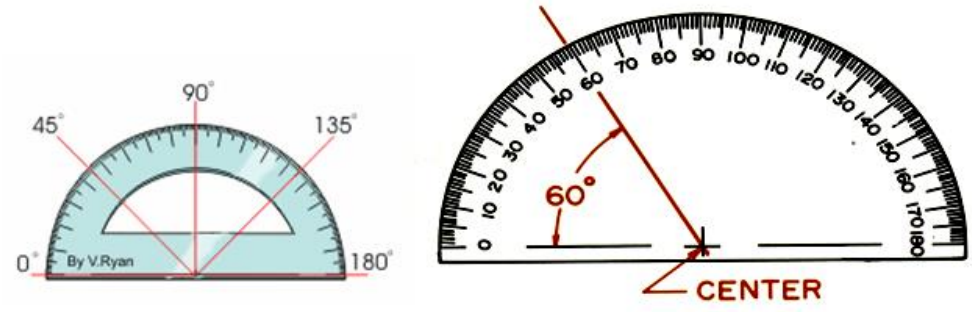


Figure.3.11 Protractor

Pencil sharpeners: -are essential for sharpening pencils.

Figure 3.12 Pencil sharpeners

A ruler should only to use to measure distances with lines being drawn with T-Squares and Set Squares.

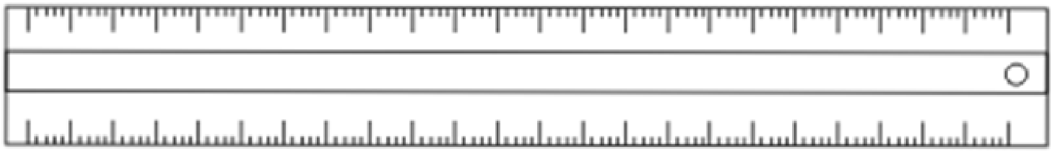


Figure 3.13 Ruler

3.2 Multi View Drawings and Product Parts.

Multiview drawing is a technique used by drafters and designers to depict a three-dimensional object (an object having height, width and depth) as a group of related two-dimensional (having only width and height, or width and depth) views. A person trained in interpreting multiview drawings, can visualize an object's three-dimensional shape by studying the two-dimensional multiview drawings of the object.

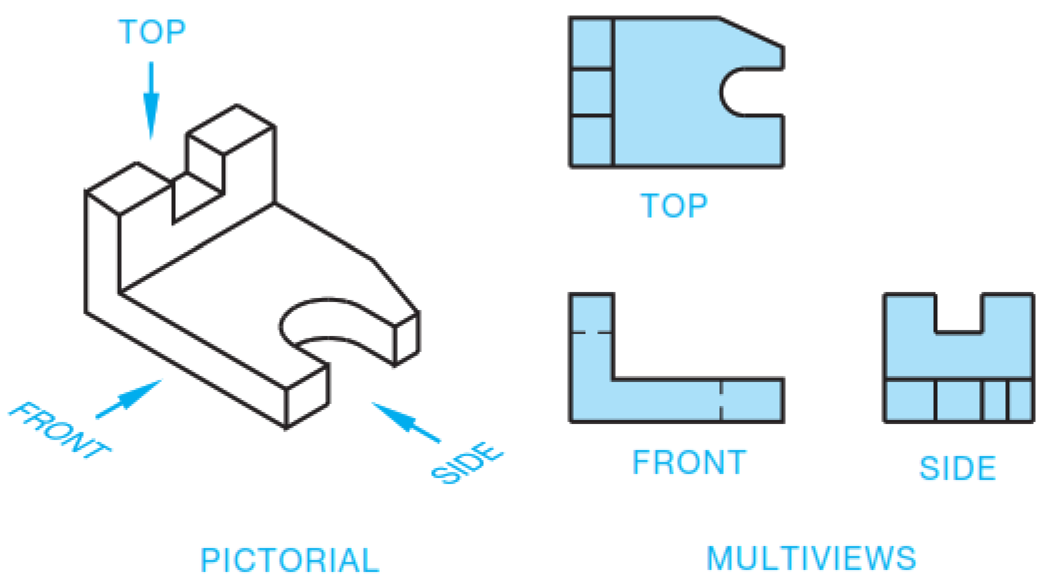


FIGURE 3.14 A pictorial view and its relationship to multi views of the same part.

Multiview projection establishes views of an object projected on two or more planes of projection by using orthographic projection techniques. The result of multi view projection is a multi view drawing. A multi view drawing represents the shape of an object using two or more views. Consideration should be given to the choice and number of views used, so the surfaces of the object are shown in their true size and shape when possible. It is generally easier to visualize a 3-D picture of an object than to visualize a 2-D drawing. In mechanical drafting, however, the common practice is to prepare completely dimensioned detail drawings using 2-D views known as multi views.

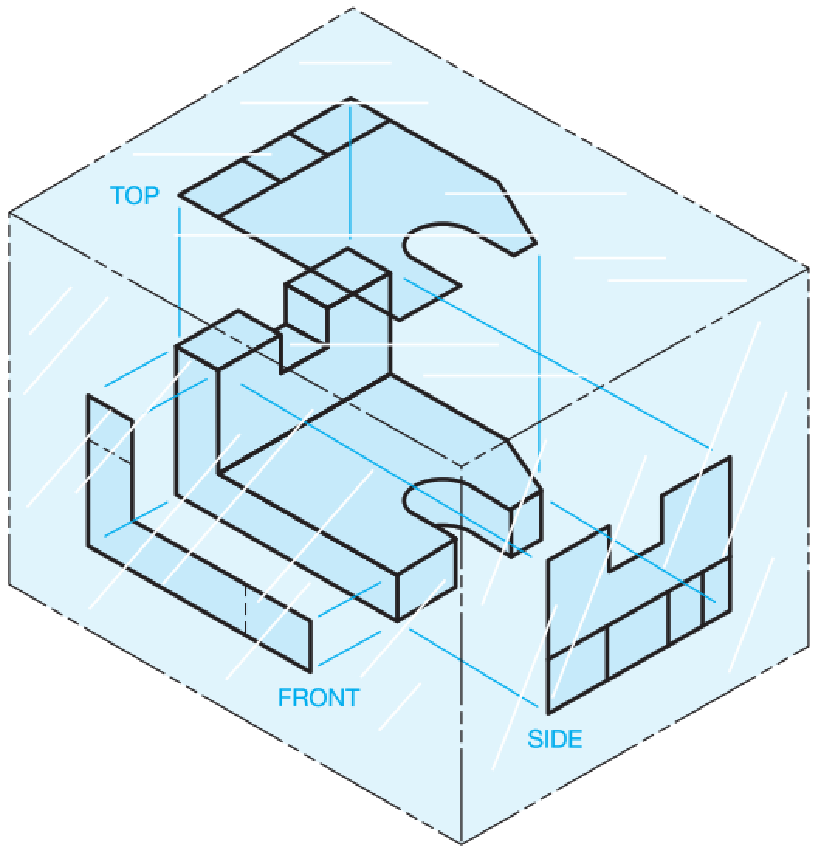


Figure 3.15 Multi-views projection using glass box

3.2.1 Product part drawing

Part drawing or detail drawing is a multi view representation of a single part with dimensions and notes which has full information and fulfill drawing standards.

Assembly drawing conveys:

- completed shape of the product
- overall dimensions
- relative position of each part
- functional relationship among various components.

Assembling drawing divided as:

1) **Exploded assembly drawings.** The parts are separately display, but they are aligned according to their assembly positions and sequences.

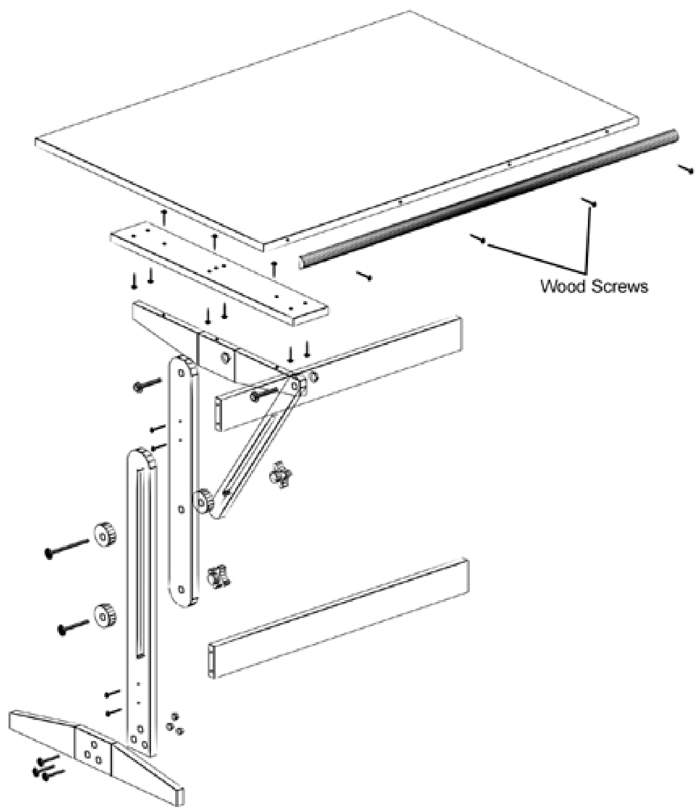


Figure 3.16 Exploded drawing

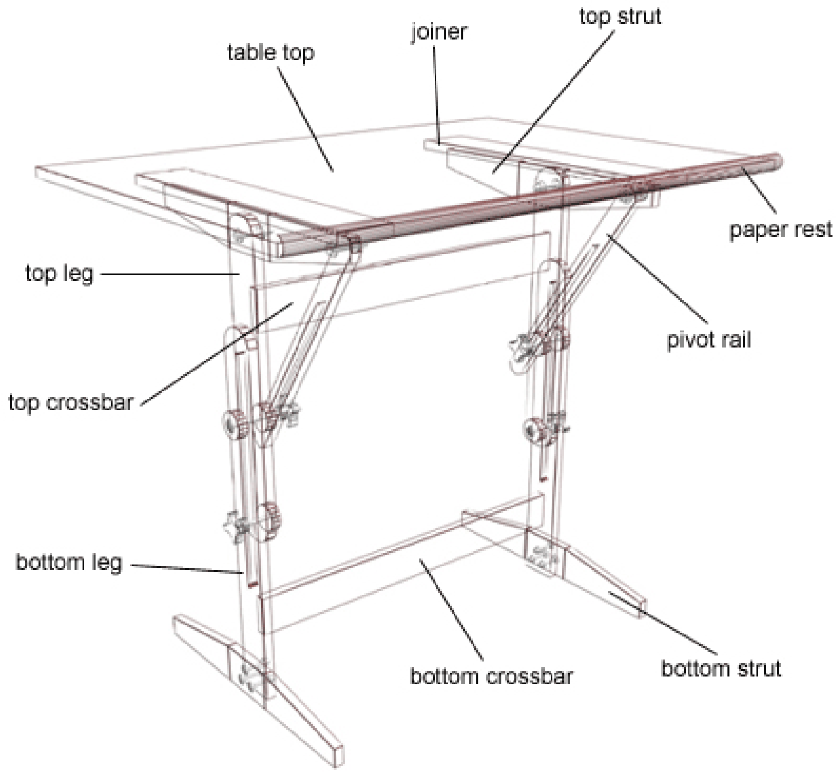


Figure 3.17 Assembled part

2) General assembly drawings. All parts are drawn in their working position. Assembly Drawings demonstrate how a number of separate subassembly drawings, detailed parts, standard components and specifications come together in a unified assembly.

Required information in general assembly drawing

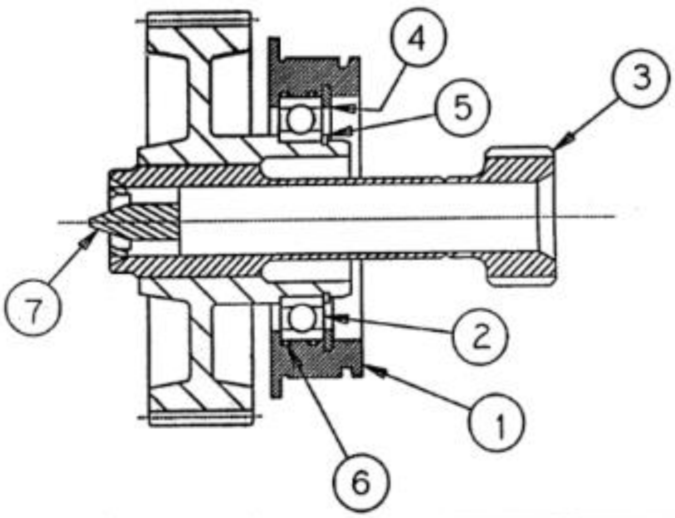
. All parts, drawn in their operating position

. Machining and assembly operations and critical dimensions related to operation of the machine

. Leader lines with balloons around part numbers

. Part list (or bill of materials, BOM.

1. Item number
3. Material, MATL.
2. Descriptive name
4. Quantity required (per a unit of machine), QTY



1		1689-207	BUTTON, SPLINE LUBRICATION		7
2		M83248/1-034	O-RING	MIL-R-83248, TYPE 1	6
1	80756	RS137	RING, RETAINING	CARBON STEEL (SPIROLOX)	5
1	89462	N5002-218	RING, RETAINING	CARBON STEEL (TRUARC)	4
1		1689-294	SHAFT ASSY, INPUT		3
1		MRC 1907-S	BEARING		2
1		1689-276	INSERT, BEARING		1
-1 QTY	FSCM NO	PART NO	NOMENCLATURE	MAT'L/SPEC	ITEM NO

Figure 3.18 General assembly

3) **Detail assembly drawings.** All parts are drawn in their working position with a completed dimension.

Self-check 3	Witten test

Parts I. write true if the statement is correct and write False if it is not correct

1. The purpose of dimensioning is to provide a clear and complete description of an object.

2. Complete set of dimensions will permit only different interpretation needed to construct the part.

3. Geometrical tolerances should be specifying for all requirements critical to functioning and interchangeability.

4. Suitable locations on the part, called datum targets

Part II: - <u>Choose the best answers</u>

1.________ is approximately 3mm long and 1 mm wide That is, the length is roughly three times the width.

A. Arrowhead B. An extension line C. a leader D. Dimension line

2.______ a thin line used to connect a dimension with particular area.

A. Arrowhead B. An extension line C. a leader D. Dimension line

3. __________ thin lines used to establish the extent of a dimension.

A. Arrowhead B. Extension Lines C. a leader D. Dimension line

Part 3. Answer all the questions listed below.

1. Explain the uses of the following technical drawing tools.

Protractor

Circular Template

Drawing pencils

T-Square

French curve

2. Write at least 5 technical drawing equipment

Operation Sheet 3	**To perform dimensional Views**

- **Operation title: - Perform dimensioning.**
- **Purpose:** To measure the dimension of geometrical shape on the given drawing
- **Instruction:** Use the given steps below the tools and equipment to draw dimensional Views
- **Tools and requirement:**

1. Ruler,
2. Scale
3. Pencil
4. Paper

- **Procedures in doing the task**

Step1 Set up your drawing paper on top of the drawing board.

Step2 Use the drawing template format given to you by your teacher.

Step3 Be sure to check the sharpness of your pencil lead. Use standard sharpening for good aesthetic result of your work.

Step4 Using the basic drawing instruments and materials, perform the drawing task in the given following problems 1 to ___ below.

Step5 Use appropriate pencil lead in your drafting works.

Step6 There are two part of problem exercises, Part A – complete the st

Step7 orthographic views by finding the missing line/s given the orthographic views and isometric view;

Step8 Part B – provide the 3 basic orthographic views (top, front and side/end views) given the isometric view.

Step9 You may submit your finish work once you are true but should be within the time specified for submission.

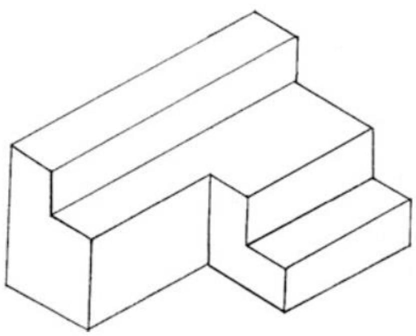
LAP Test 3	Practical Demonstration

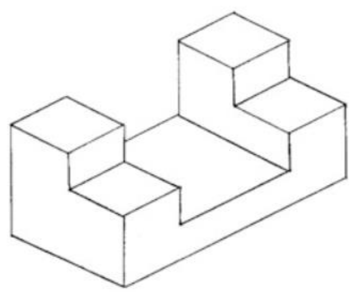
Name: ______________________________ Date: ________________

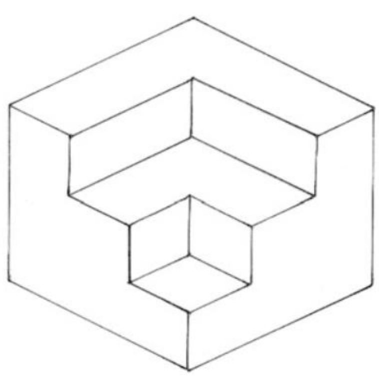
Time started: ________________________ Time finished: ________________

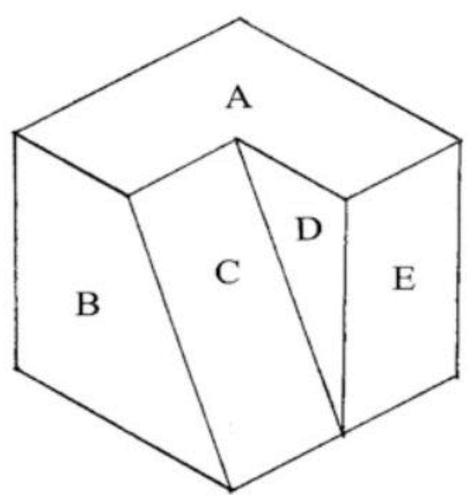
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 4 hours**. Perform the following tasks**

Task: 1: Given the following four isometric drawings. Draw the orthographic projections needed to fully describe the parts. Choose the best direction for the front view. Use scale 1:1 and take dimensions directly measuring with ruler.









Unit Four: Interpret technical drawing

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Checking and validating drawings with standards
- Recognizing components and assemblies
- Identifying dimensions, instructions and material requirements
- Compiling list of required materials

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

- Check and validating drawings with standards
- Recognize components and assemblies
- Identify dimensions, instructions and material requirements
- Compile list of required materials

4.1 Checking and validating drawings with standards

Drafting standard and drawing management system has been established, a drawing validation process must exist to ensure compliance with corporate standards. Oftentimes this consists of one or more drafters or checkers performing drawing audits from within AutoCAD software using various tools like check standards, this process can be time-consuming and costly especially when a large number of drawings must be processed within a short time period.

Several third-party checking exists to check the standard with drawing requirements and standards that require the external expert. Validation should take place from the early to the final stages of drawing and even after final work. The concerned experts and the engineers as well as manufacturers need to validate the work of drawings and check all the standard fulfillment.

4.2 Recognizing components and assemblies

Recognizing of part components related with the total number of parts of drawing. Checking the whole parts of drawing helps to assemble the details and able to determine the types of materials, quantity and other related data. It is also used for inventory of parts that are going to be assembled. For the production of the component study of detail and assembly drawing is very important. When we need a particular component or object it is possible to give some specification and which describe its shape, size and dimensions. According to these dimensions, the designer or producer can understand and/or manufacture it.

4.3 Assembling the drawing

Assembly drawing is a drawing of various parts of a machine or structure assembled in their relative working positions. Assembling is defined as joining of different part components and assembling of multi views. Sometimes there are given parts of an object using the orthographic illustration, your concern will be identifying the perspective figure to complete a task. An example figure below is given to find the perspective.

Given multi-views

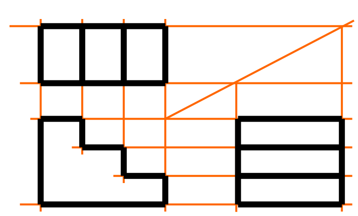


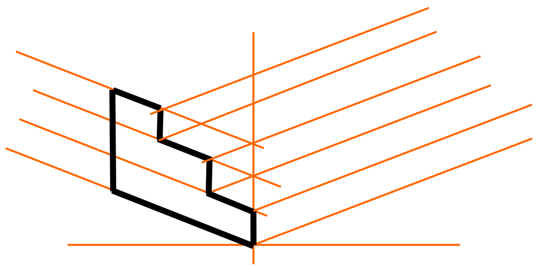
Figure 4.1 Assembling multi-Views

- **Steps to create assembling drawing**

Step 1: Follow the procedures of Isometric drawing. Create first the 30º angles Used in creating Isometric figures.

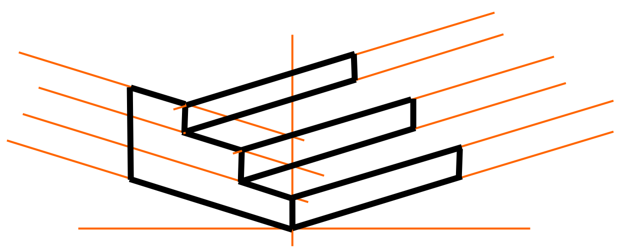
Step 2: draw the front view first, following the given measurements.

Project the side view after completing the front view.



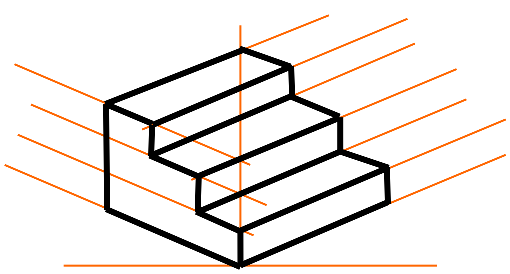
Step 2

Step 3: draw the side view according to the details or measurements given.



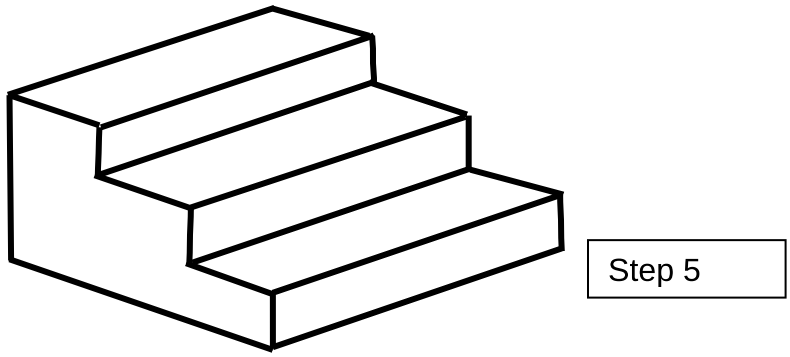
Step 3

Step 4: Project the remaining lines that will complete the top view. After completing the figure, erase all unnecessary lines or the projection lines.



Step 4

Step 5: Erase construction lines



4.4 Identifying dimensions, instructions and material requirements

Dimensions

A drawing without dimensions is meaningless. Dimensions are necessary to show the exact size of an object. Dimensioning refers to the act of giving dimensions, i.e., length, width, height, diameter, etc., of the object. This information is provided by giving numeric values to various features of the object on the drawing. A feature is an individual characteristic such as a flat or cylindrical surface, a slot or a groove, a taper, a shoulder, a screw thread, etc.

Dimension is a numerical value expressed in appropriate units of measurement and indicated graphically on technical drawings with lines, symbols and notes. The important aspects of dimensioning are as follows:

- ✓ Units of Measurement: On technical drawing we need to show lengths and angles. The most convenient unit for length is millimeter. In civil engineering and architectural drawing, inch or foot is often used as a unit of length. Angles are shown in degrees.
- ✓ Symbols: Are incorporated to indicate specific geometry whenever necessary.
- ✓ Notes: Are provided to give specification of a particular feature or to give specific information necessary during the manufacturing of the object.

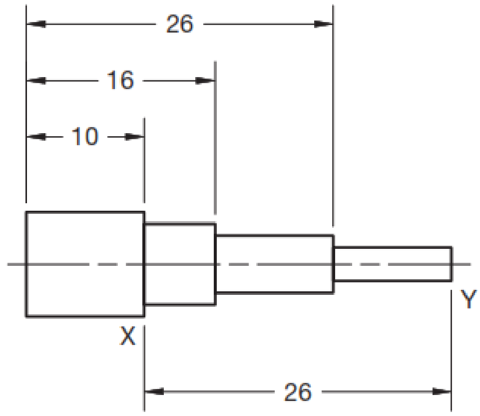


Figure 4.2 Dimensioning of a part

<u>Elements of dimensioning</u>

<u>A line</u> on the drawing whose length is to be shown is called and <u>*object line*</u>. The object line is essentially an outline representing the feature(s) of the object. While showing an angle, the two lines forming the angle will be the object lines.

<u>Dimensioning</u> is often done by a set of elements, which includes *extension lines*, *dimension lines*, *leader lines*, *arrowheads* and *dimensions*.

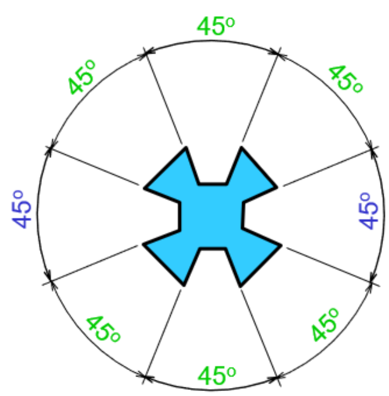


Figure 4.3 Dimensioning of angles

- ✓ <u>*Extension line*</u> – is a short line drawn perpendicular to an object line. These line start immediately or a few millimeters from the ends of object lines and extend a few millimeters beyond a dimension line. Extension lines may be used to show an angle due to space constraint. In such case, extension lines are drawn parallel to and at the ends of object lines.

- ✓ *<u>Dimension line</u>* – is drawn between two extension lines parallel to the object line. As a rule, there must be one and only one dimension line between any two extension lines. One dimension line represents one dimension. While dimensioning an angle, a curved dimension line is drawn by drawing a suitable are having its center at the vertex of the angle.
- ✓ *<u>Leader line</u>* – is a line which connects a note or a dimension with the feature to which it applies. Leaders are drawn at suitable angles, preferably 30º, 45º or 60º, and are never drawn horizontal or vertical. One end of the leader carries an arrowhead which connects it to the outline of the object.

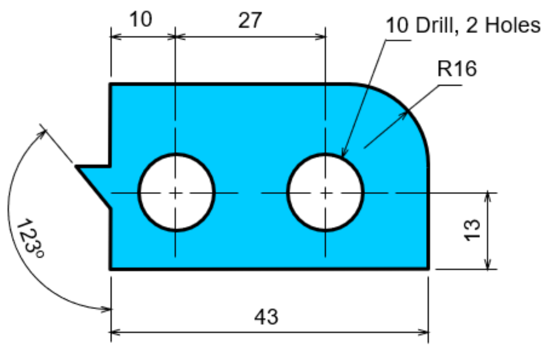


Figure 4.4 Usage of extension line, dimension line and leader line

- ✓ Arrowheads – an arrowhead is drawn at each end of a dimension line. The tip of an arrowhead touches the extension line. An arrowhead is also drawn at the end of a leader, which points out the feature of an object.

4.5 Compiling list of required materials

Compiling drawings and other necessary documents are very important to use the files as reference and to get experiences. Compiling list of materials covers:

- to put together (documents, drawing and instructions, etc) in a folder.
- to put written materials from various sources such as to compile files and other necessary documents to use them in the future.
- to gather and compile data.
- compiling using computer data base also recommended.

Self-check 4	

Give short answer

1) what is assembling drawing?
2) How do you compile the required drawing materials?
3) Write the elements of dimensioning.
4) What is the difference between detail drawing and assembling drawing?
5) What is the use of recognition of detail parts for the assembling?
6) How do you validate the standard?

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