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## Introduction

**Drawing**

A drawing is a graphical representation of a real thing. To draw something as a figure by means of lines expressing some ideas on the paper is known as a drawing. The purpose of the drawing is to define and specify the shape and size of a particular object by means of lines and other information about the object. A good drawing gives full information about the object in the shortest and simplest ways.

**Engineering Drawing**

A drawing worked out by an engineer, having engineering ideas, for engineering purpose is known as Engineering Drawing. It is the universal graphical language of engineers. Every language has its own rules of grammar. Engineering drawing also has been diverse according to certain rules. It has its own conventions in the theory of projection, the types of lines, its abbreviations, symbols and its description. The knowledge of the drawing is the most important requirement of all the technical persons to work in an engineering occupation.

A technician expresses his ideas on paper through the medium of drawing. A complete working drawing of a job is prepared in brief. It is then followed up by the workers who give accurate shape to the raw materials according to the drawing. If technician commits a little error in the initial drawing work, it is carried over in the practical work by the workers resulting in the loss of time, money, material and labor. As a result, the production efficiency of the factory decreases. Therefore, it is extremely important for the engineers, designers, supervisors, draftsmen, mechanics and other workers engaged in production to have a thorough knowledge of engineering drawing.

## Objective

The ability to read drawing is the most important requirement of all technical people in engineering profession. The potentialities of drawing as an engineer's language may be made use of as a tool for imparting knowledge and providing information on various aspects of engineering.



## Significance

Engineering drawing is the two-dimensional representation of a three-dimensional object. It is the graphic language from which a trained person can visualize the object. As an engineering drawing displays a precise picture of the object to be produced, it conveys the same picture to every trained eye. Drawings prepared in one country may be utilized in any other country, irrespective of the language spoken there. Hence, engineering drawing is called the universal language of engineers. By means of drawing, the shape, size, finish, color and construction of any object can be described accurately and clearly in the simplest and shortest way. The quality of any engineering drawing depends on the following factors:

- Ability to visualize the job in three dimensions.
- A clear conception and appreciation of the shape, size, proportion and design. • Clarity of expression of ideas on the paper by sketches.
- Speed and accuracy of the drawing work
- Interests in the drawing works

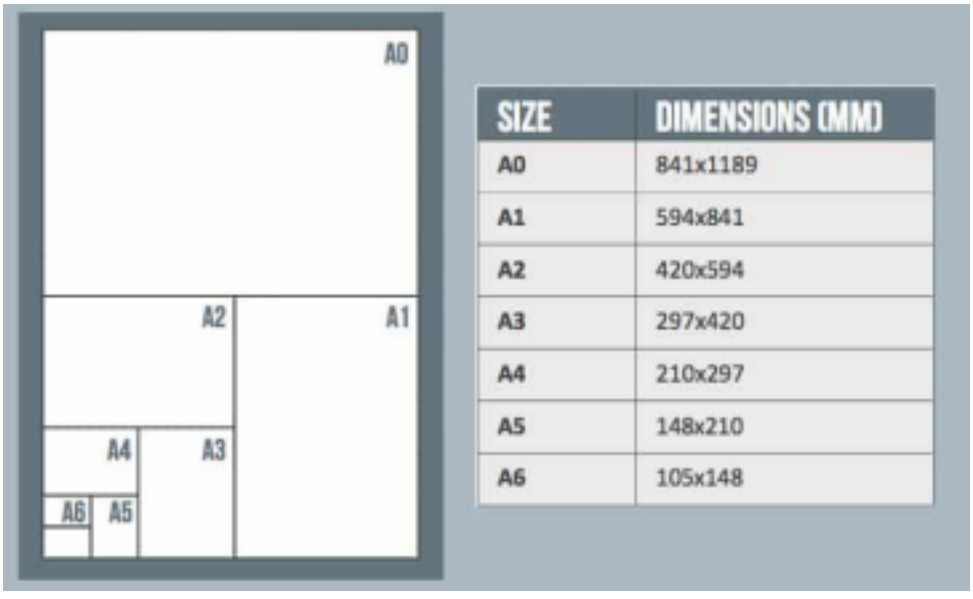
## Utility

The numerous utilities of engineering drawing are as follows:

- As it is the representation of an object on a single plane, even a huge object can be drawn on a small piece of paper with all the necessary details of the object. • It precisely and fully gives shape of an object and contains all the information required for its manufacture, inspection or maintenance.
- It also supplies the information regarding the exact size, material, the relative position, finish and accuracy of the parts.
- Even large machining operations can be represented by small symbol



**Drawing Sheets**




| SIZE | DIMENSIONS (MM) |
|---|---|
| A0 | 841x1189 |
| A1 | 594x841 |
| A2 | 420x594 |
| A3 | 297x420 |
| A4 | 210x297 |
| A5 | 148x210 |
| A6 | 105x148 |

**Various Drawing Tools**



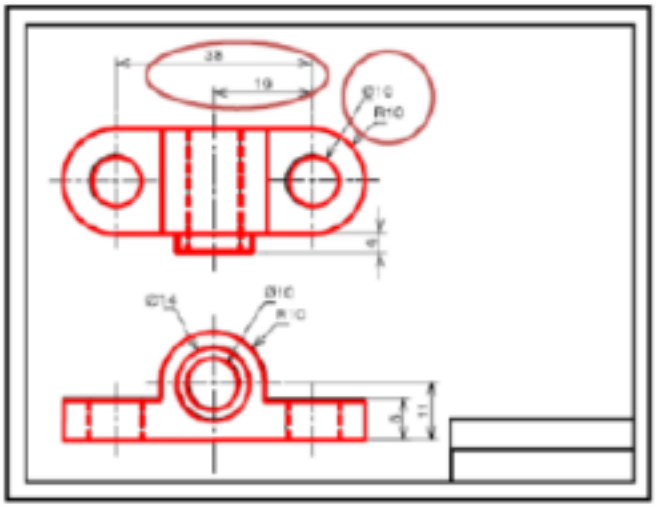

## Standard Engineering Lettering

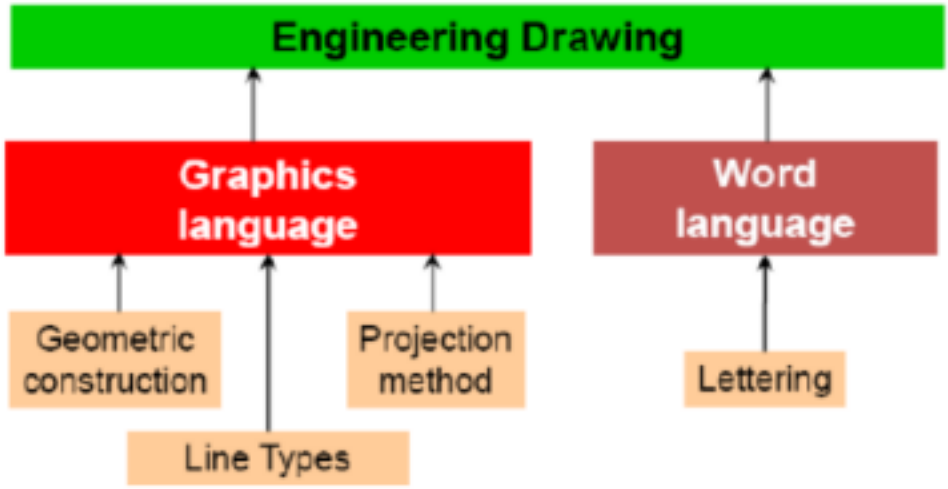
### Elements of Engineering Drawing

Engineering drawing are combination of graphic language and word language.

***Graphic Language:*** Mainly describes a shape

***Word Language:*** Describes an exact size, location and specification of an object.








## Lettering in Engineering drawing

Lettering is used to provide easy to read and understand information to supplement a drawing in the form of notes and annotations. Lettering is an essential element in both traditional drawing and Computer Aided Design (CAD) drawing. Thus, it must be written with:

*Legibility*- shape and space between letters and words.

*Uniformity*- size and line thickness

### Types of Lettering

The two types of lettering are:

1. Double Stroke Lettering: In Double Stroke Lettering the line width is greater than that of Single Stroke Lettering.
   Double Stroke Lettering is further divided into two types.
   a) Double Stroke Vertical Gothic Lettering
   b) Double Stroke Inclined Gothic Lettering

   A stencil is mostly used when hand drawing double stroked letters.

2. Single Stroke Lettering: Thickness in single stroke lettering is obtained by a single stroke of pencil or ink pen. It is further divided into two types.
   a) Single Stroke Vertical Gothic Lettering
   b) Single Stroke Inclined Gothic Lettering

## Conventions for Lettering

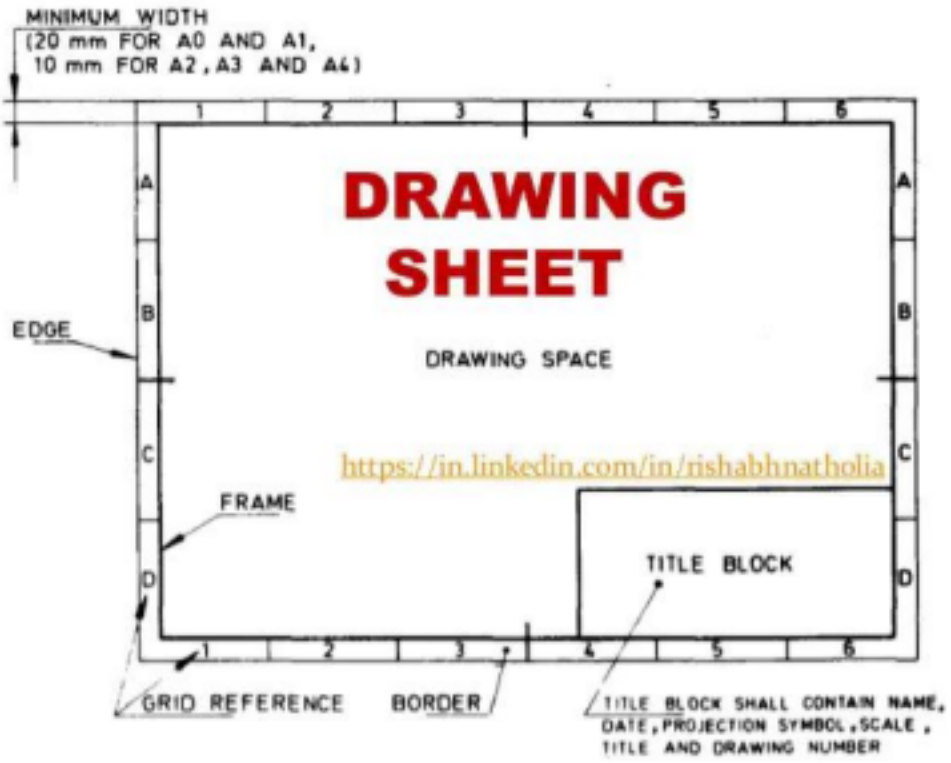
- Use all **CAPITAL LETTERS.**
- Use *even pressure* to draw precise, clean lines.
- Use *one stroke* per line.
- **Horizontal Strokes** are drawn *left to right.*
- **Vertical Strokes** are drawn *downward.*
- **Curved Strokes** are drawn *top to bottom* in one continuous stroke on each side. •

Use the *Single-stroke, Gothic Style of Lettering.*

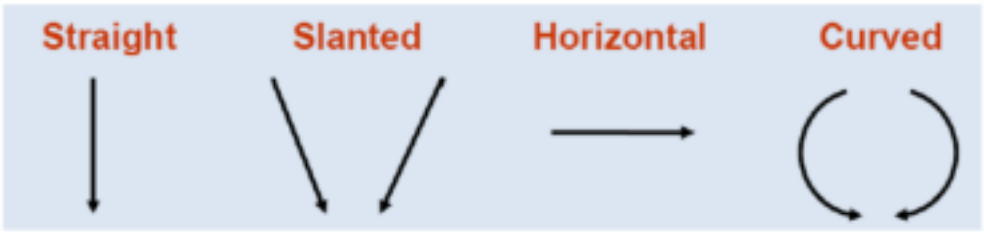
- Always *skip a space* between rows of Letters.
- **Fractions** are Lettered *Twice the height of normal letters.*
- **Fraction Bars** are always *drawn Horizontal.*

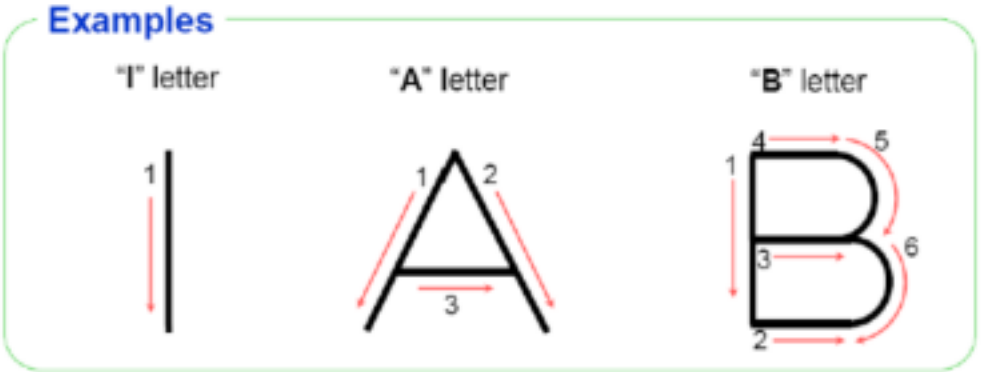


## Title box




## Basics of Single Stroking



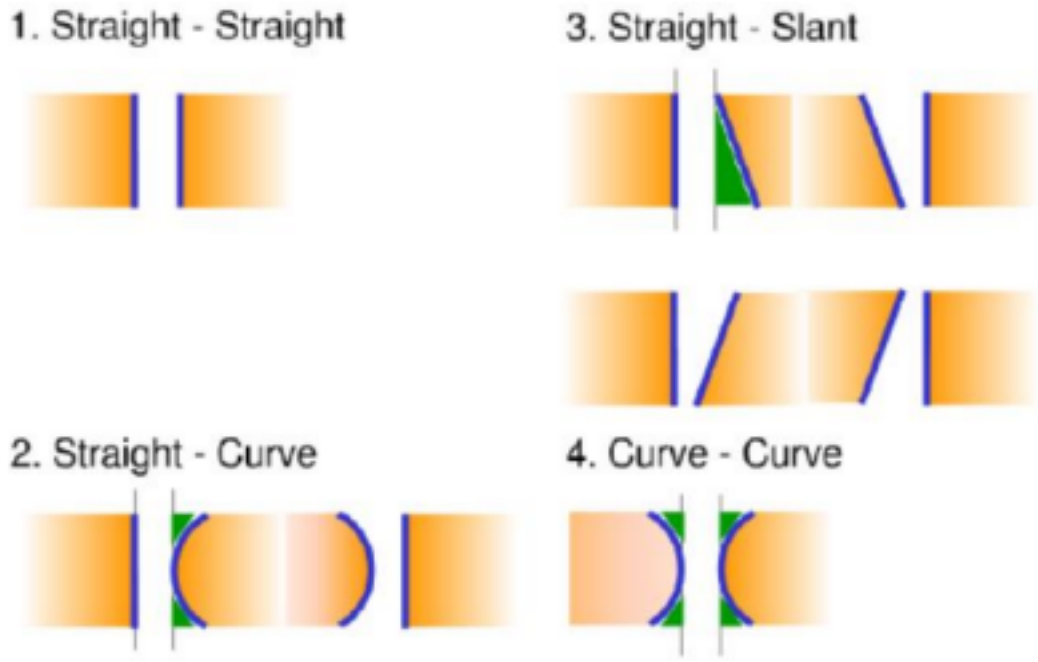
## Spacing

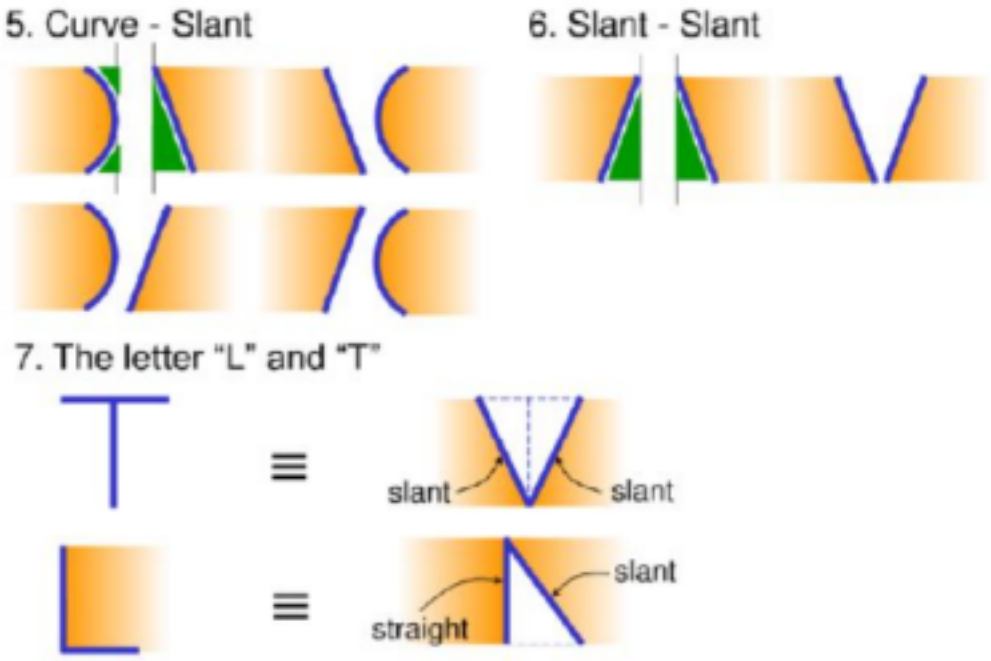
Uniformity in spacing of letters is a matter of equalizing spaces by eye.

- The background area between letters, not the distance between them, should be approximately equal.
- Words are spaced well apart, but letters within words should be spaced closely.


- For either upper case or lower-case lettering, make the spaces between words approximately equal to a capital O.


## Space between letters






## Drawing Scales

Scale is the ratio of the linear dimension of an element of an object shown in the drawing to the real linear dimension of the same element of the object. Designation of a scale consists of the word "SCALE' followed by the indication of its ratio as follows:

SCALE 1:1 for full size

SCALE X:1 for *enlargement* scales (X>1)

SCALE 1:X for *reduction* scales (X>1)

Dimension numbers shown in the drawing correspond to "true size" of the object and they are independent of the scale used in creating that drawing.

### *Introduction*

To manufacture a part, dimensioning plays a significant role. Engineering drawing without dimensioning is meaningless. If a drawing of a part is done and the scale is mentioned, it does not become sufficient for manufacturing. By direct measurement from the drawing the part cannot be produced accurately for many reasons. Whatever may be the scale of the part, the actual size dimensions have to be always mentioned on the part. Dimensions are indicated on the drawings by arrowheads, extension lines, dimension lines, leaders, figures, notes, symbols etc. in order to define the geometric characteristics such as, lengths, diameters, angles, locations etc. The lines used in the dimensions are thin compared to the visible lines. The dimensions must be clear, concise and always allow the single interpretation. Standard rules of dimensioning have to be followed unless it becomes essential.

### *Arrowheads*

The important part of the dimensioning is the arrowhead. The arrowhead may be drawn in accordance with Figure 2.1. Arrowheads are usually drawn freehand. However, all arrowheads have to be identical in shape and size throughout the drawing unless it becomes essential. Sometimes it becomes necessary to shorten them due to space limitation. The length of the arrowhead may vary depending on the size of the drawing. The approximate length of the arrowhead may be 3 mm. However, for the larger drawing it may be a little bit larger in size. **The approximate ratio of the length to width of the arrowhead is 3:1** as shown in the figure. The arrowhead must touch the line. It must not be either away from the line or cross the line.

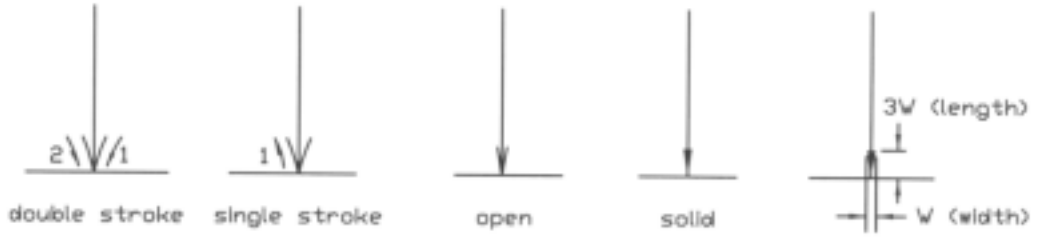
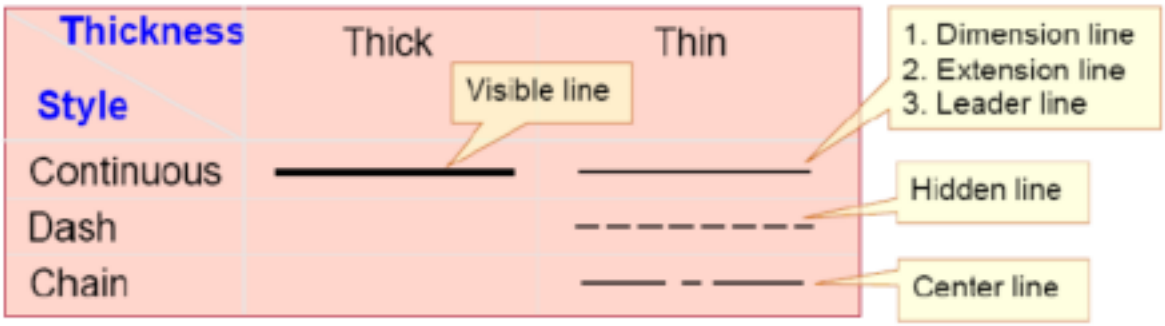



Figure 2.1: Arrowheads




***Extension Line, Dimension Line***

Extension and dimension lines are used to show dimension of a part. Extension lines indicate the point or line on the drawing to which the dimension is applied while dimension lines show the dimensions. On the other hand, leaders are used to present note, dimension, symbol, item number or part number on the drawings. They are thin lines. Extension and dimension lines are introduced in the following Figure.

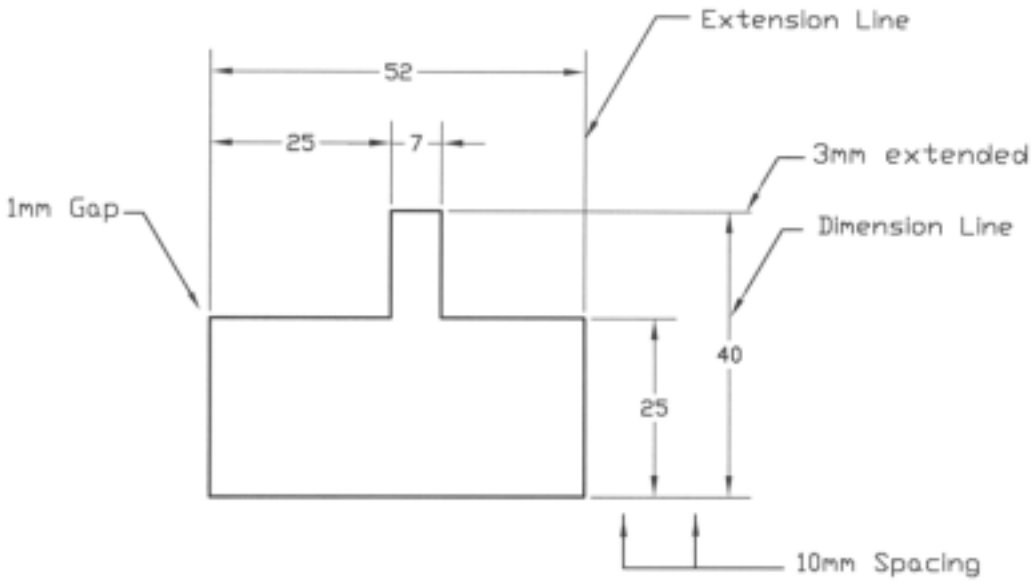



Figure: Extension and Dimension Lines

The following rules are to be remembered while inserting dimensions on a part.



***Extension Line***

(1) **A gap of 1 mm has to be kept** in between the extension line and the visible line. (2) **An extension line should extend about 3 mm** from the outermost dimension line. (3) Extension lines may cross each other without a break. They may also cross the visible lines

without a break**. If the extension lines cross arrowheads or dimension lines close to arrowheads, a break may be permissible**.

(4) **Centerlines may be used as extension lines**. However, it should not be broken while passing the circle.

(5) Extension lines are usually drawn perpendicular to dimension lines, where there is overcrowding extension lines may be drawn at an oblique angle.

### *Dimension Line*

(1) **Dimension line should be approximately 10 mm away** from the visible line. The spacing between the consecutive parallel dimension lines may also be considered as 10 mm. (2) Dimension lines are broken near the middle to allow space for dimension. (3) Dimension lines should usually be placed outside the view unless it becomes necessary. (4) When the space in between the extension lines is too small to insert dimension line completed with arrowhead, it may be provided outside the extension line. (5) To accomplish it the shortest dimension line should be placed nearest to the outline of the part.

**(6) Centerlines should never be used as dimension lines.**

(7) In case of extra-long dimension line or crowding of dimensions, dimension lines inside the view may be permissible.

(8) When several dimension lines are required side by side along a line, it is recommended to stagger them.

(9) The dimension line for a part, which cannot be presented completely on the drawings due to its large distance, the free end is terminated in a double arrowhead pointing in the direction in which it could be completed.

### *Leader Line*

(1) Thin lines used to connect a specific note to a feature.

(2) Also used to direct dimensions, symbols, item number and part numbers on a drawing.

(3) Commonly drawn at 45, 30 and 60 degrees.

(4) Has **a short shoulder** (3-6mm) at one end beginning at the center of the vertical height of text, and a standard dimension arrowhead at the other end touching the feature. (5) Leader lines should not cross each other.

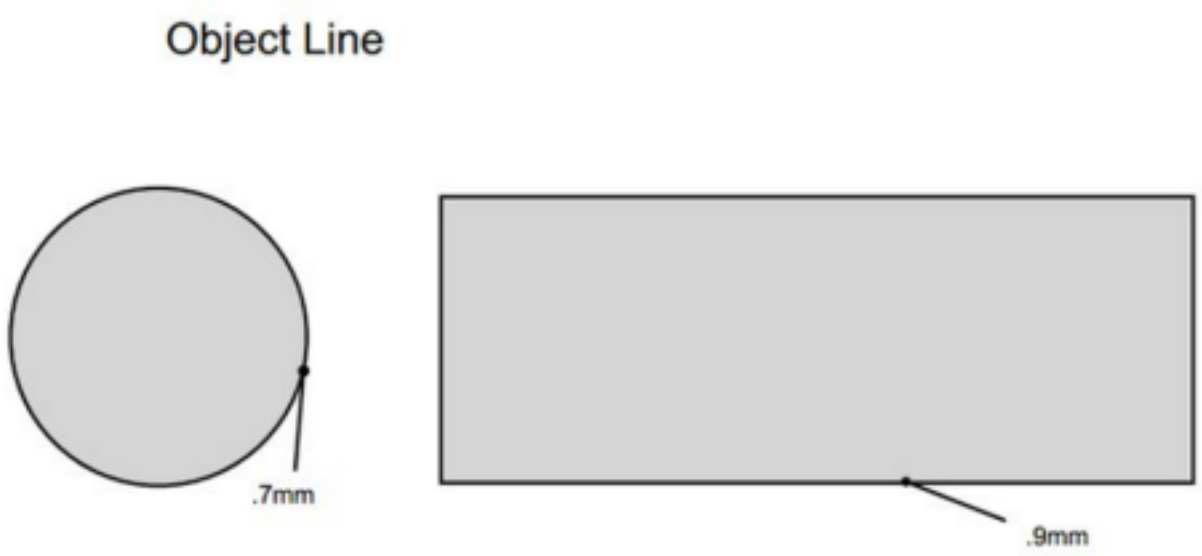
(6) Leader lines should not be excessively long.

(7) Leader lines should not be vertical or horizontal.

(8) Leader lines should not be parallel to dimension lines, extension lines or section lines.



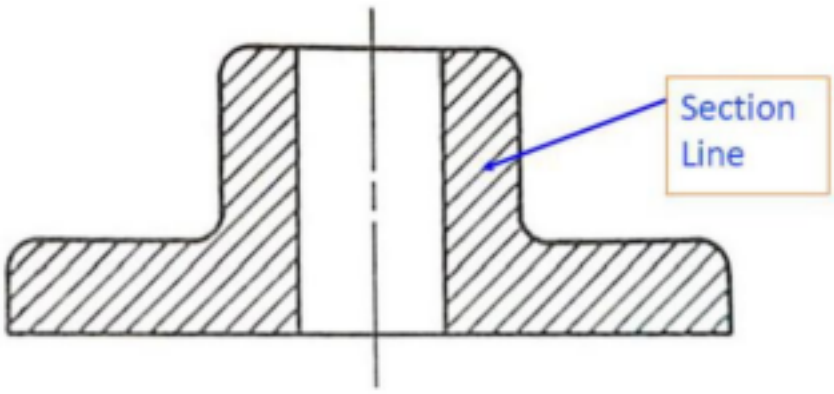
### Object Line




**Object lines are solid heavy lines, .7 mm to .9 mm**. These lines define the shape of the object portrayed and are the outermost outline of the object. A round bar is shown as a circle in one view and a rectangle in the other. Both would be drawn with object lines.

**Section Line**

- Thin line usually drawn at a 45-degree angle.
- Indicates the material that has been cut through in a sectional view.

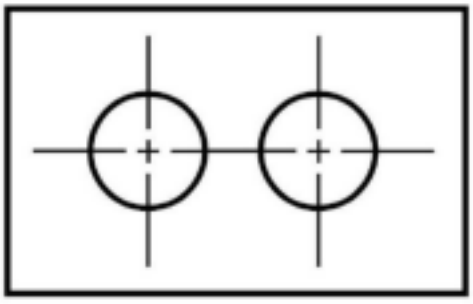


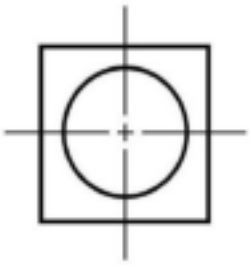



**Center Line**

**0.3-0.5 mm**

**A center line is a .3 mm to .5 mm line** that alternates between short and long dashes. It is used to identify a hole as shown from the side. If a hole were in a plate, the center line would locate the center in the view where the feature isn't shown. Center line should start and end with short and long dash. Center lines should intersect by crossing either the long dashes or short dashes. It should extend a short distance beyond the object or feature. Center lines may be connected within a single view to show that two or more features lie in the same plane. It should not extend through the space between views.





Correct



**Hidden Line**

**A hidden line is a .3 mm to .5 mm dashed line**. It is light, narrow and short dashed line. It shows features, such as holes, in a view they are not in. The feature will be shown in another view of the drawing. Hidden line should always begin and end with a dash. **Exception:** When the hidden line begins or ends at a parallel visible or hidden line. The dashes should join at corners.



**Break Line**

**A break line is a .3 mm to .5 mm or .7 mm to .9 mm line with "Z" breaks, for a flat object, and "S" breaks, for a round object**. These are used to show that a portion of the part is not shown. The area left out will not have any features that are unique yet is the same as what is shown. An example would be a rod that is threaded on both ends. Break lines would be used to eliminate the section between the threaded sections to shorten the object.

**Projection**

- Projections transform point from n (here, n=3) dimensional space of dimension less than n (Here, n=2)
- Points to be considered-
  - ✓ Location of object
  - ✓ Location of observer
  - ✓ Plance of projection
  - ✓ Projectors/ line of projection.

**Orthographic Projections**

■Orthographic Projections is a technical drawing in which different views of an object are projected on different reference planes observing perpendicular to respective reference plane.

■Different Reference planes are-

–Horizontal Plane (HP)

–Vertical Plane (VP)

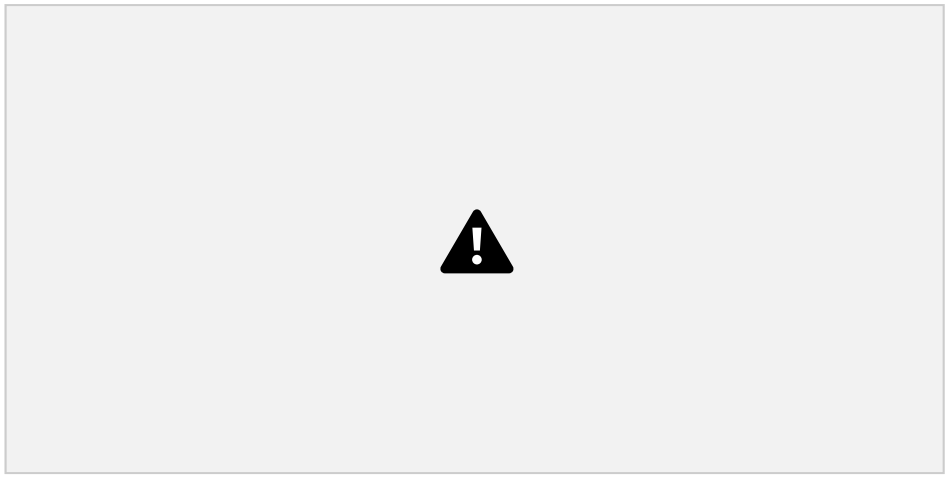
–Side or Profile Plane (PP)

■Different views are-

*–Front View (FV) –Projected on VP*

*–Top View (TV) –Projected on HP*

*–Side View (SV) –Projected on PP*





**Top View**

**Front View**

**Right Hand View**



**Top View**

**View**

**Front**
**View**

**Right Hand**