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Introduction to Engineering Graphics

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INTRODUCTION

What is an Engineering Drawing ?

"An Engineering Drawing is a technical (not artistic) drawing which clearly defines and communicates a design to other interested parties. Other parties may have an interest in design collaboration, procurement / purchasing, costing, manufacturing, quality control, marketing, handling / packaging."

Drawing:

- The way of conveying the ideas through the systematic lines on the paper.
- The art of representation of an object by systematic lines on a paper.

Classification:

1. **ArtisticDrawing(Free-handorModelDrawing):**

   The art of representation of an object by the artist by his imagination by keeping the object before him.

   e.g. paintings, cinema posters, advertisement boards, etc.

2. **EngineeringDrawing(InstrumentDrawing):**

   The art of representation of engineering objects.

   e.g. buildings, roads, machines, etc.

1. Artistic Drawing

The art of representation of an object by the artist by his imagination or by keeping the object before him.

e.g. paintings, cinema posters, advertisement boards, etc.

Typesof Engineering Drawing:

i. **GeometricalDrawing:**

e.g. geometrical objects - rectangle, square, cube, cone, cylinder, etc.

a. **PlainGeometricalDrawing:**

Two dimensional drawing having only length and breadth.

e.g. square, triangle, etc.

b. **Solid GeometricalDrawing:**

Three dimensional drawing having length, breadth and thickness.

e.g. cube, prism, etc.

ii. **MechanicalEngineeringorMachineDrawing:**

e.g. mechanical engineering objects – machines, machine parts, etc.

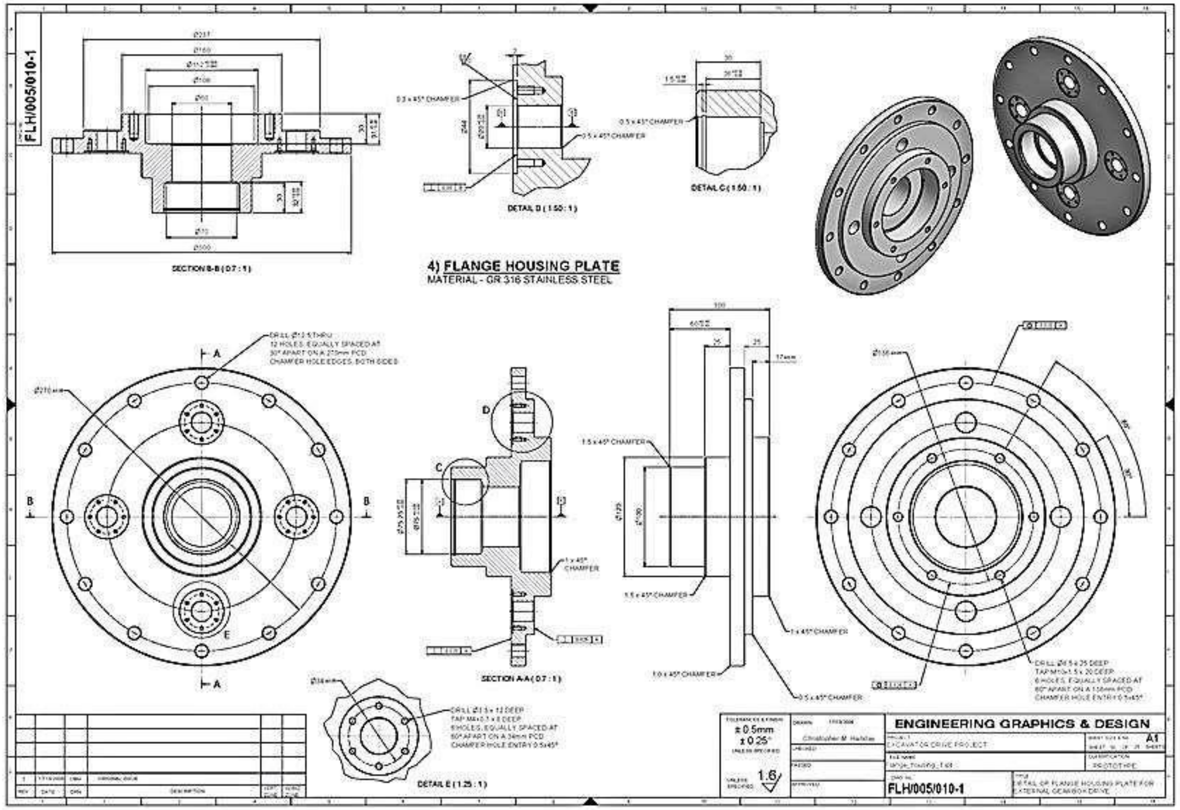
iii. **Civil EngineeringDrawing:**

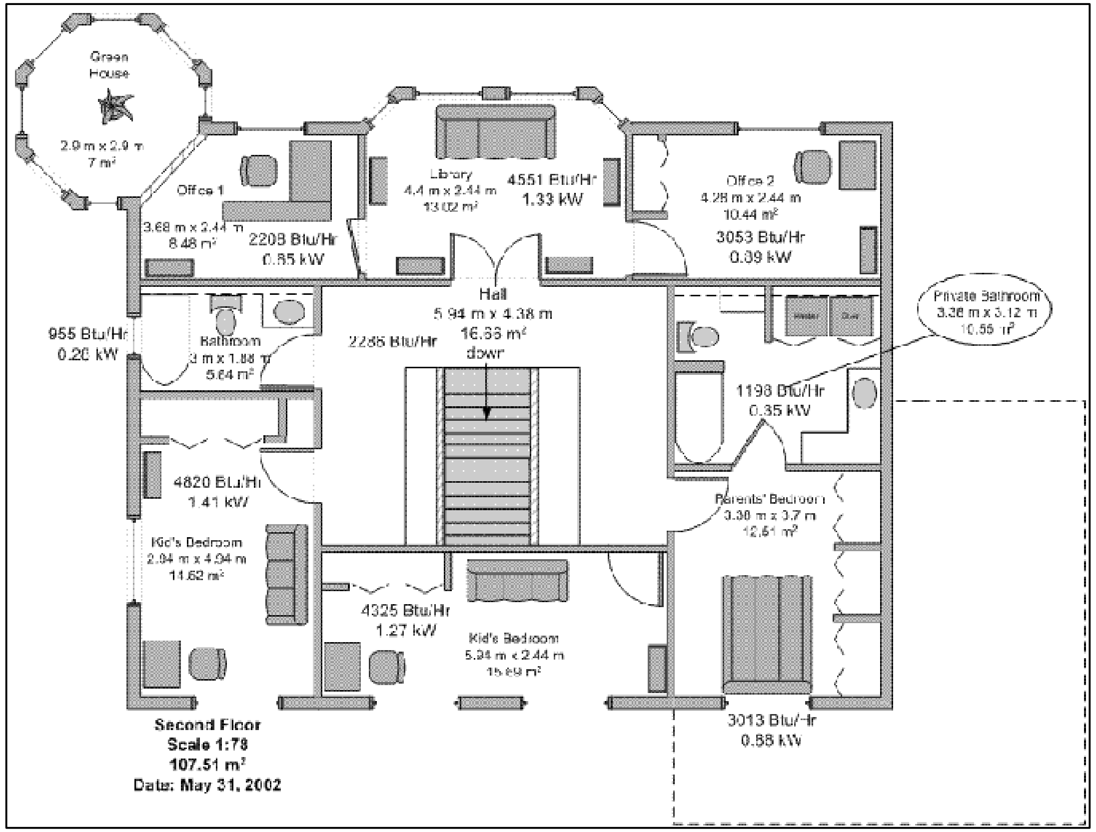
e.g. civil engineering objects – roads, buildings, bridges, dams, etc.

iv. **Electrical&ElectronicsEngineeringDrawing:**

e.g. electrical and electronics objects – transformers, wiring diagrams.

2. Engineering Drawing





The art of representation of engineering objects.

e.g. buildings, roads, machines, etc.

Role of Graphics

- Visualization
- Communication
- Documentation

Applications of Engineering Drawing

Ships

Applications of Engineering Drawing

Manufacturing of Automobiles

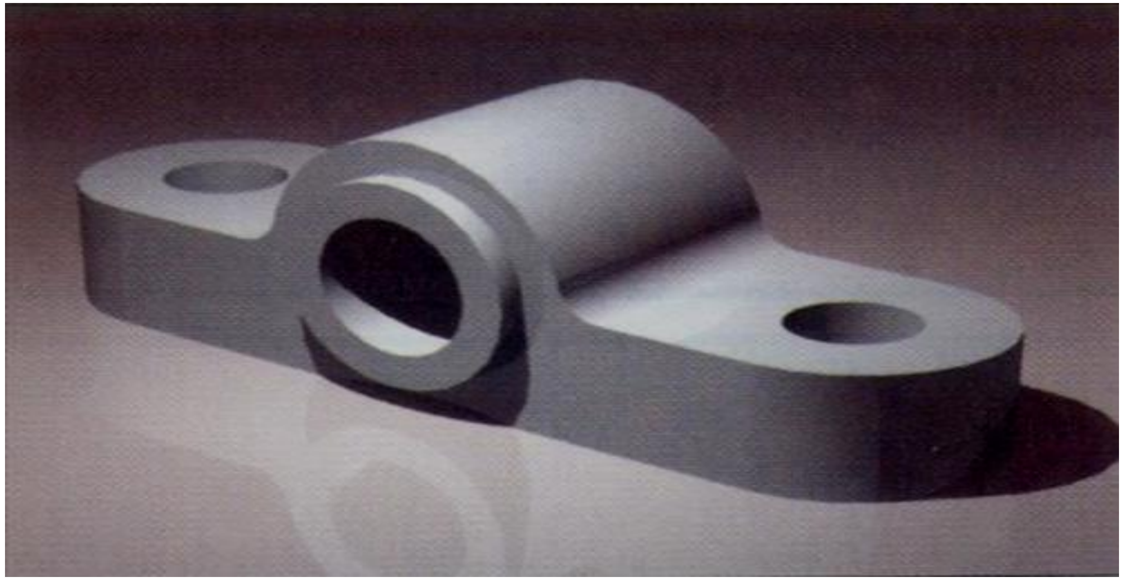
Applications of Engineering Drawing

Construction

Effectiveness of Graphics Language

1. Try to write a description of this object.

2. Test your written description by having someone attempt to make a sketch from your description.



You can easily understand that …

The word languages are <u>inadequate</u> for describing the ***size***, ***shape*** and ***features*** completely as well as concisely.

Composition of Graphic Language

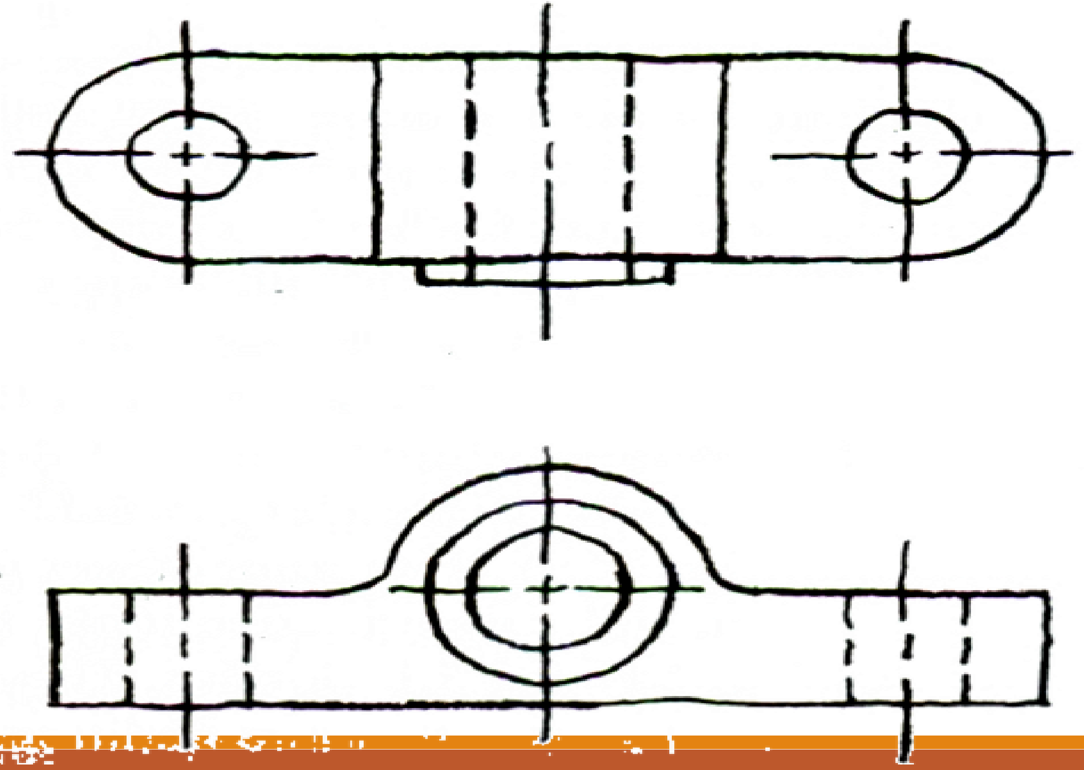
Graphic language in **"engineering application"** use ***lines*** to represent the ***surfaces***, ***edges*** and ***contours*** of objects.

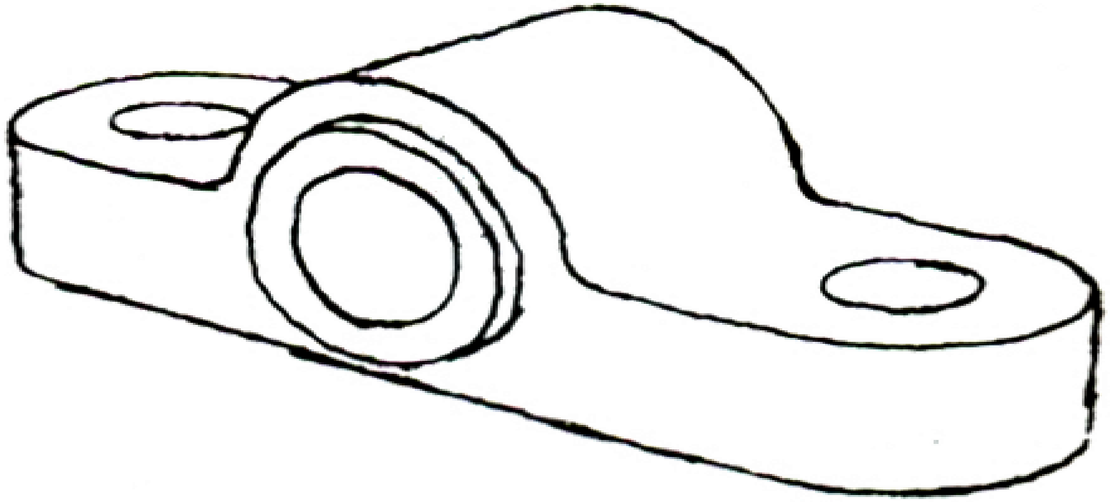
- The language is known as "***drawing***" or "***drafting***" .
- A drawing can be done using ***freehand***, ***instruments*** or ***computer*** methods.

Freehand drawing

The lines are sketched without using instruments other than pencils and erasers.

Example

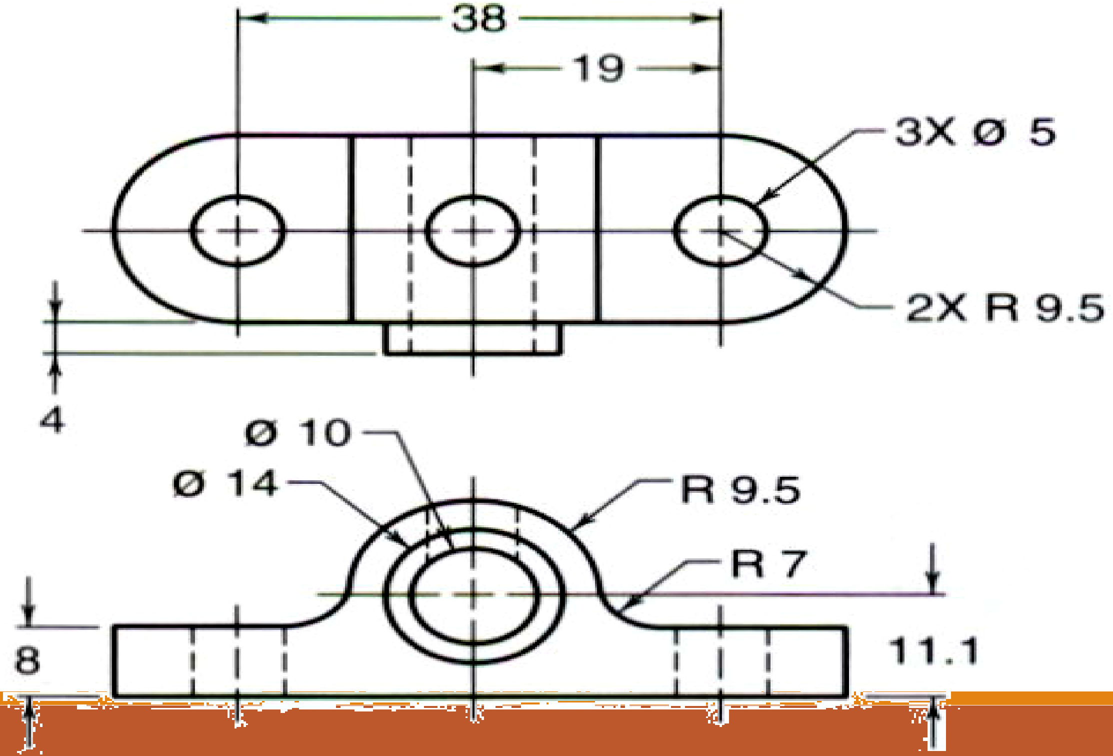




Instrument drawing

Instruments are used to draw straight lines, circles, and curves concisely and accurately. Thus, the drawings are usually made to scale.

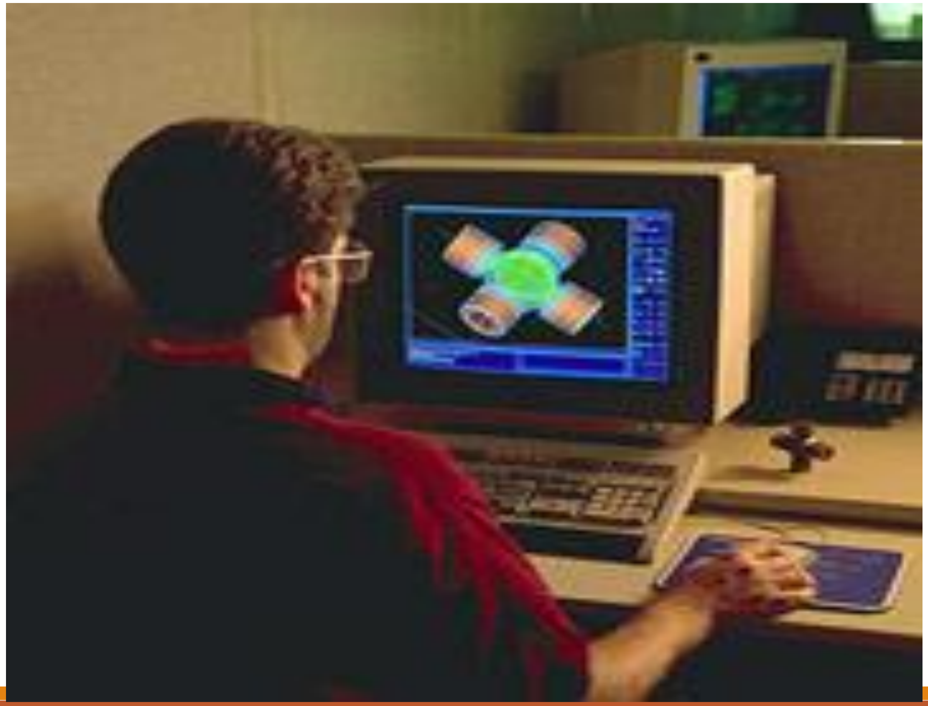
Example

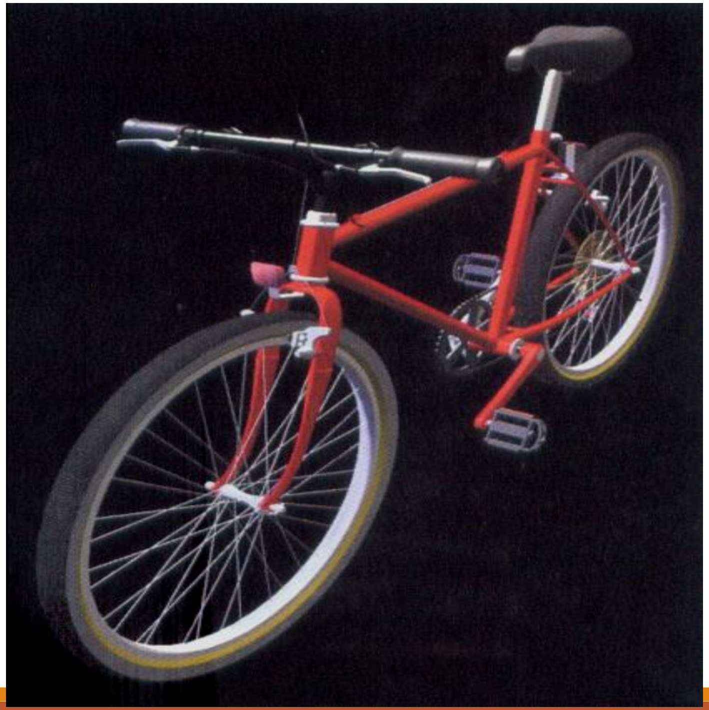


Computer drawing

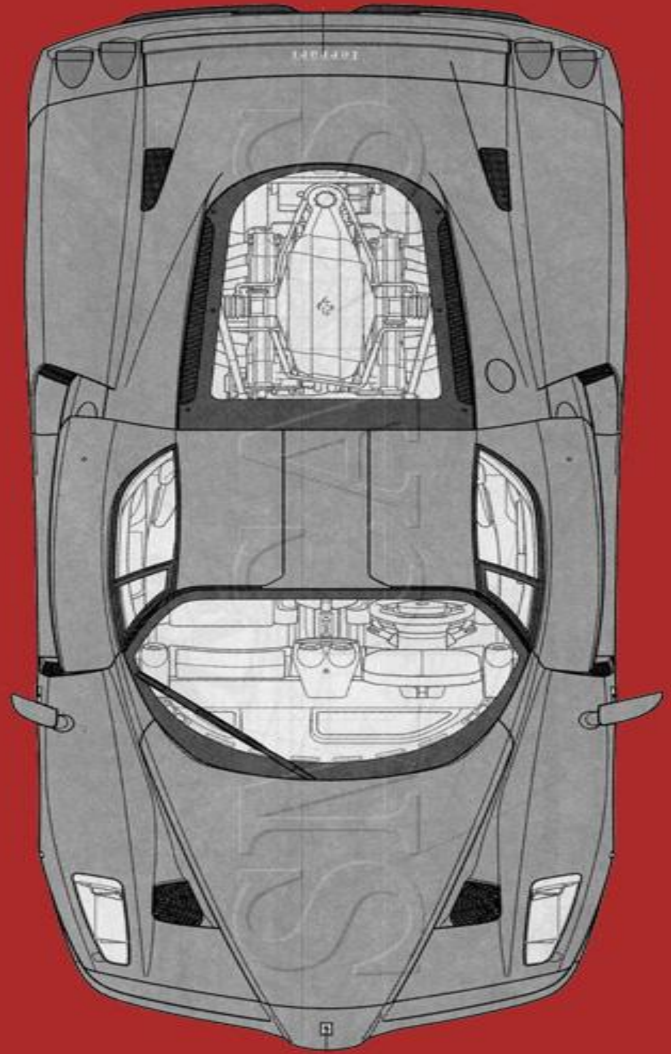
The drawings are usually made by commercial software such as AutoCAD, solid works , PRO – E, etc.

Examples

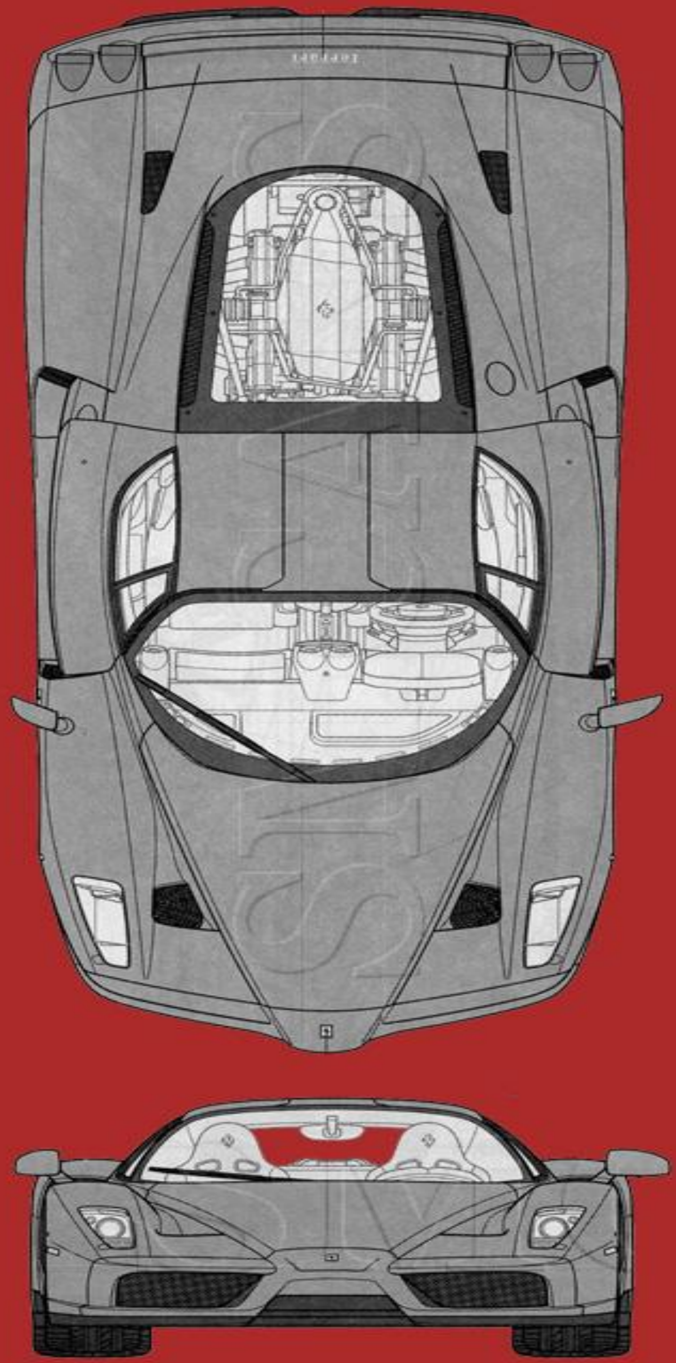




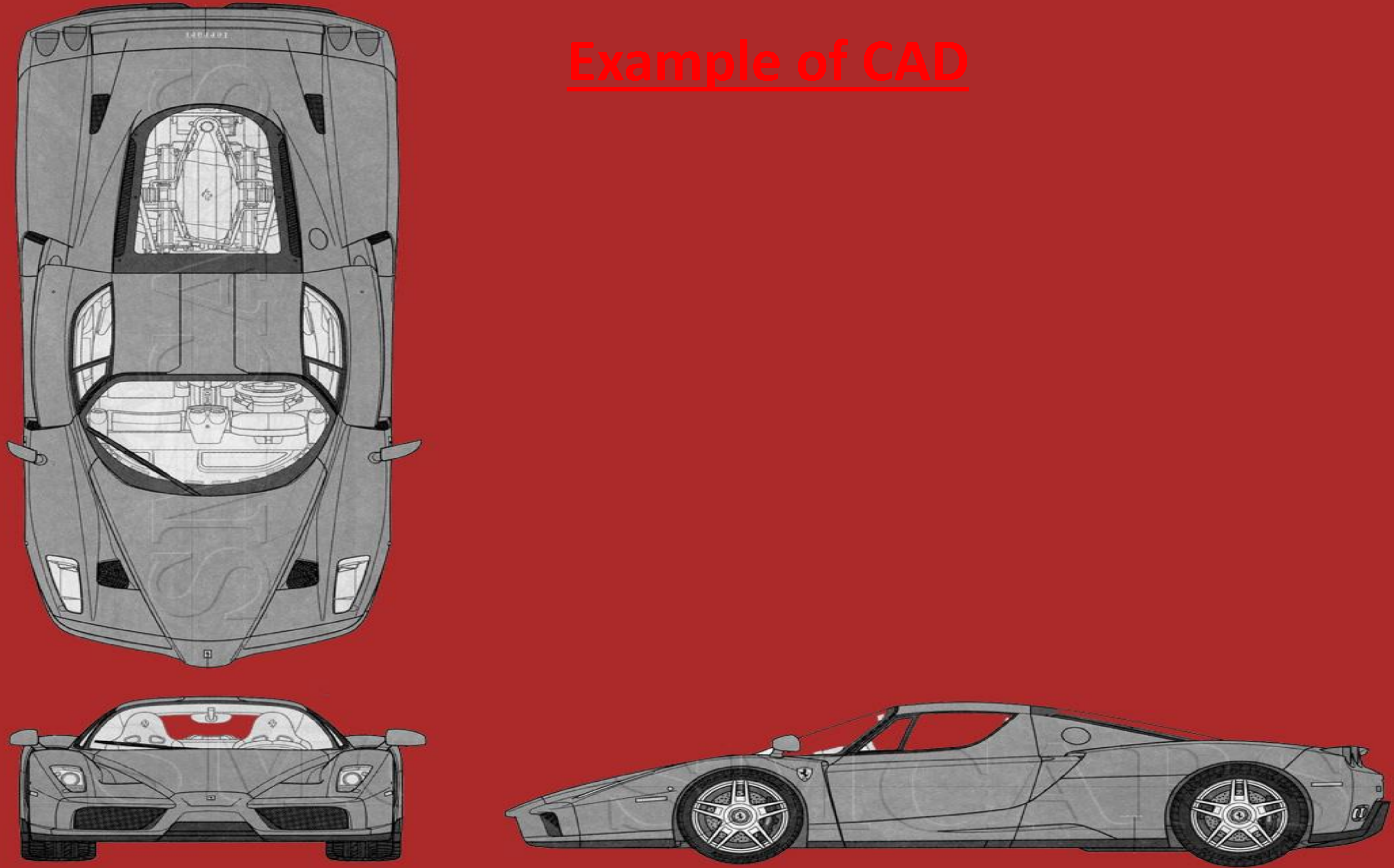
Example of CAD



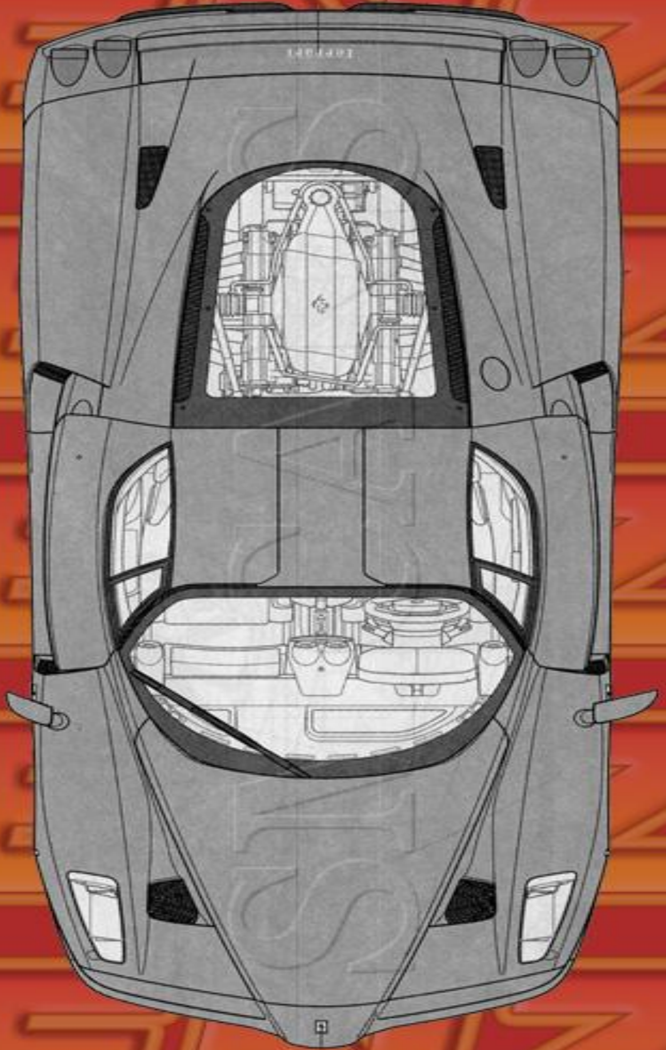
Example of CAD



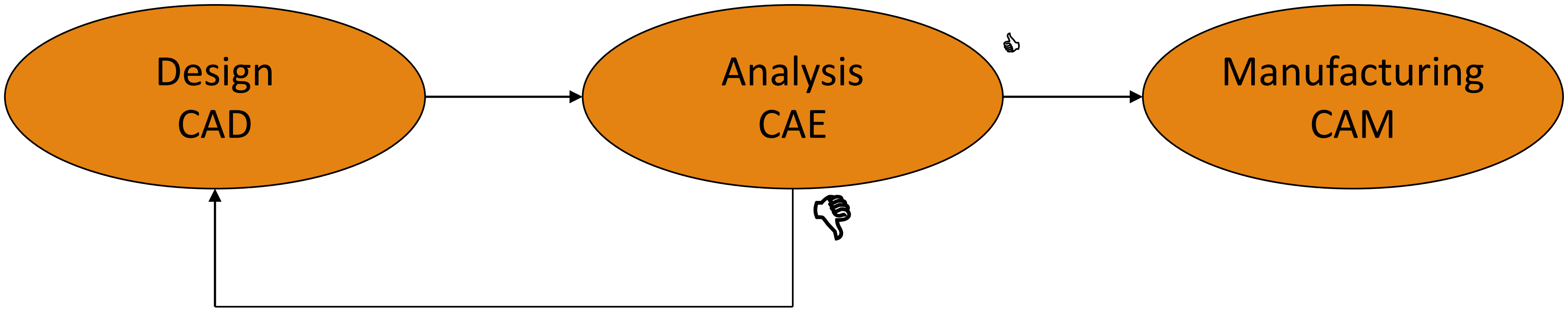
Example of CAD

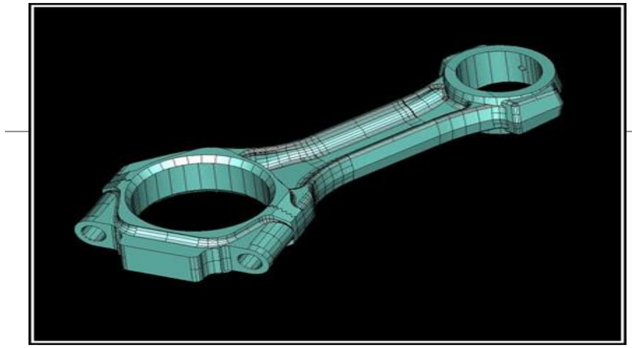


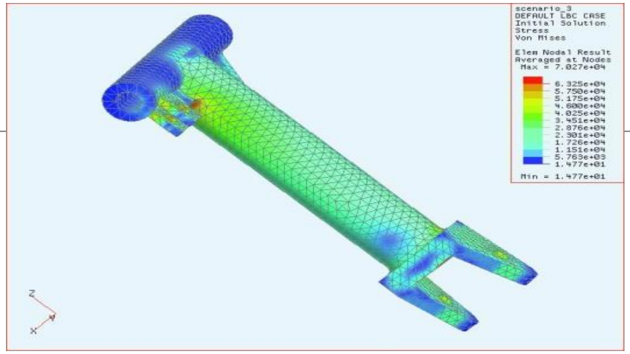
Example of CAD

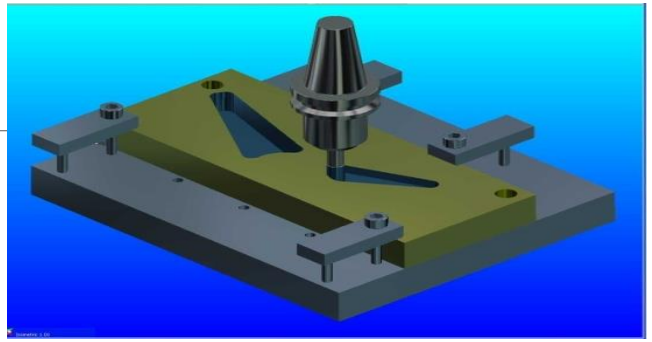


Simple CAD/CAE/CAM Product Lifecycle









Elements of Engineering Drawing

Engineering drawing are made up of ***graphics language***

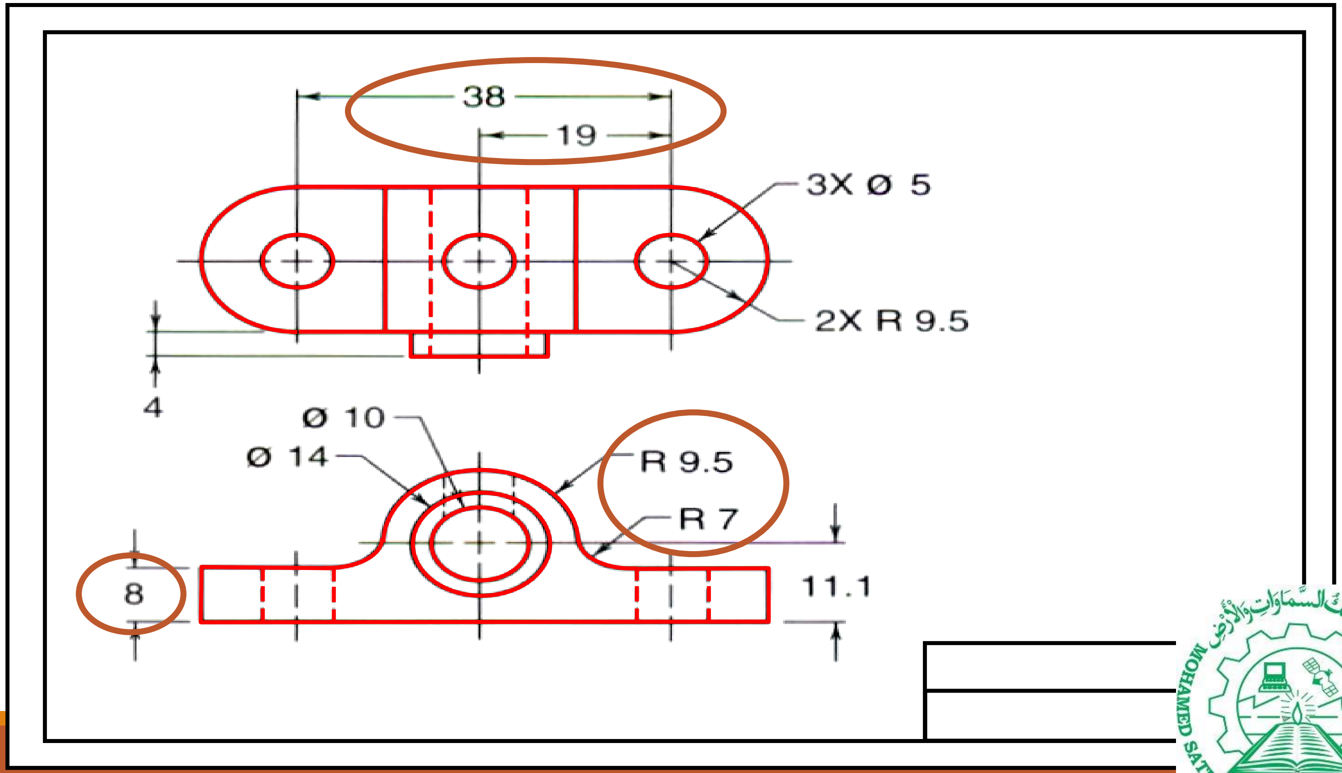
and ***word language***.

Graphics language

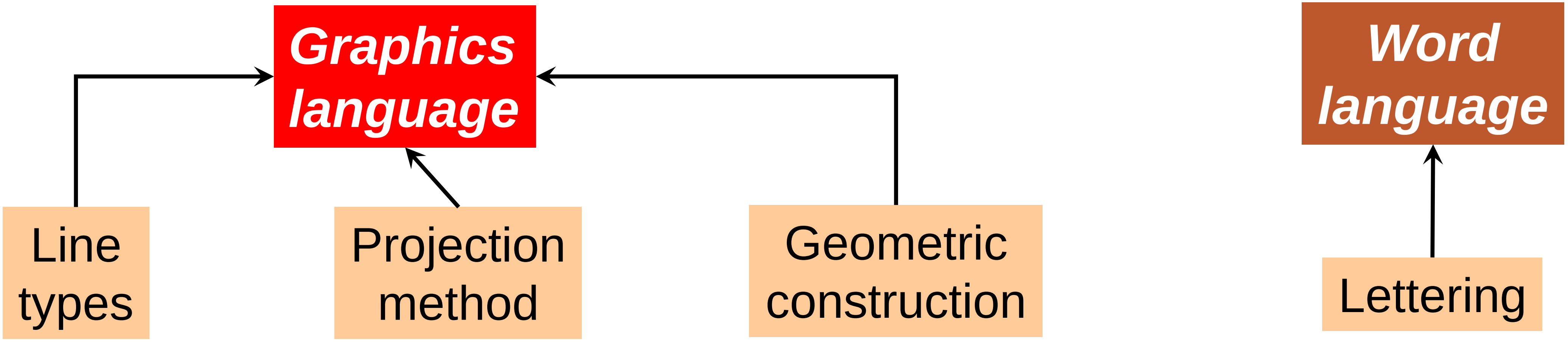
Describe a shape (mainly).

Word language

Describe size, location and specification of the object.



Basic Knowledge for Drafting



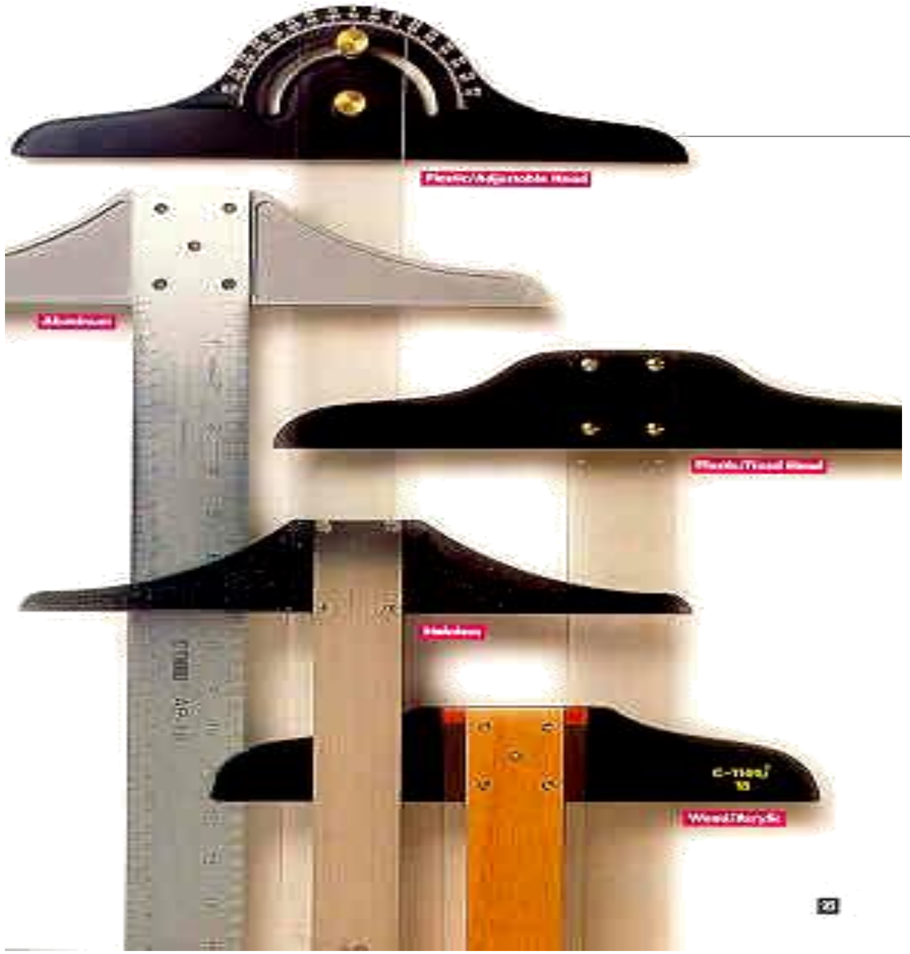
Traditional Drawing Tools

Drawing Instruments

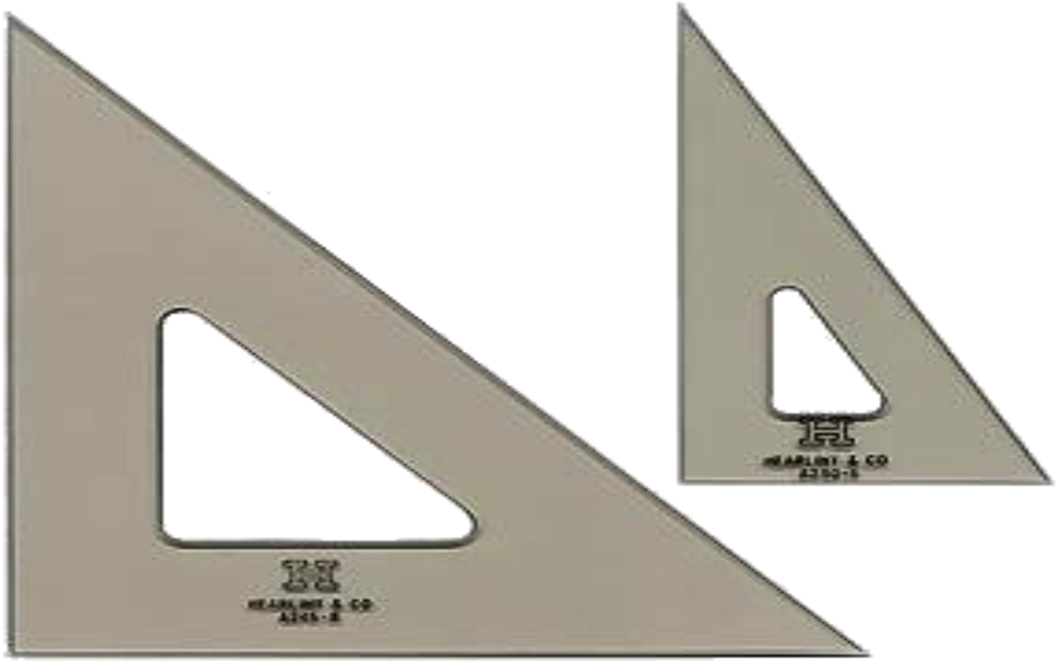
1. Drawing Board
2. Drawing Sheet
3. Drawing Sheet Holder
4. Set-squares – 45^o and $30^o – 60^o$
5. Large size Compass
6. Small bow Compass
7. Large size Divider
8. Small bow Divider
9. Scales – 6” and 12”
10. Protractor
11. French Curve
12. Drawing Pencils – H, 2H, HB
13. Sand Paper
14. Eraser (Rubber)
15. Drawing Pins and Clips
16. Cello Tape
17. Duster or Handkerchief
18. Drafting Machine / Mini Drafter
19. Sketch Book (Medium size)
20. Roller Scale
21. Pencil Sharpener
22. Sheet Folder

TECHNICAL DRAWING BOARD

DRAWING TOOLS



1. T-Square



2. Triangles

DRAWING TOOLS

2H or HB for thick line

4H for thin line

3. Adhesive Tape

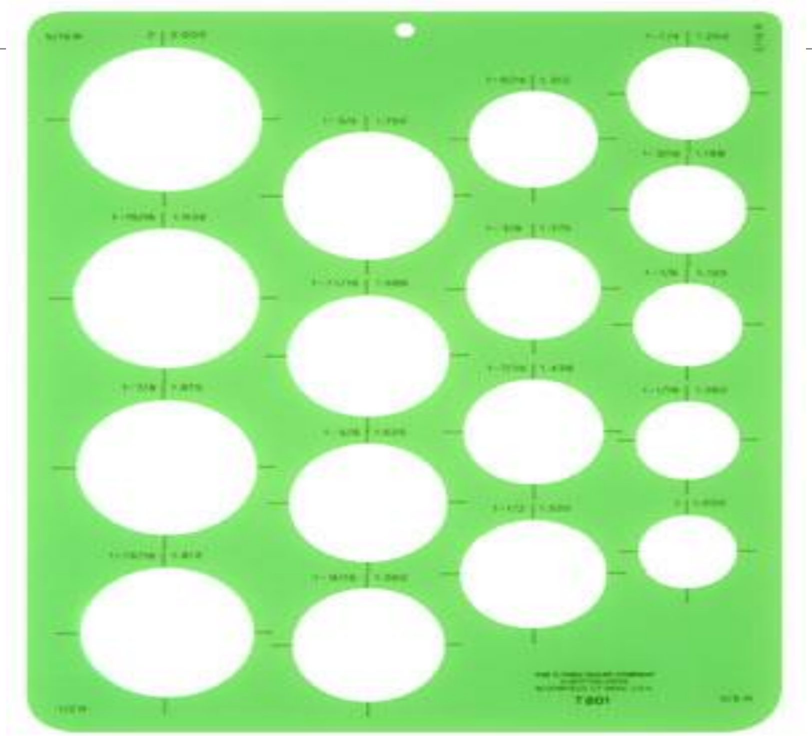
4. Pencils

DRAWING TOOLS

5. Pencil Eraser

6. Compass

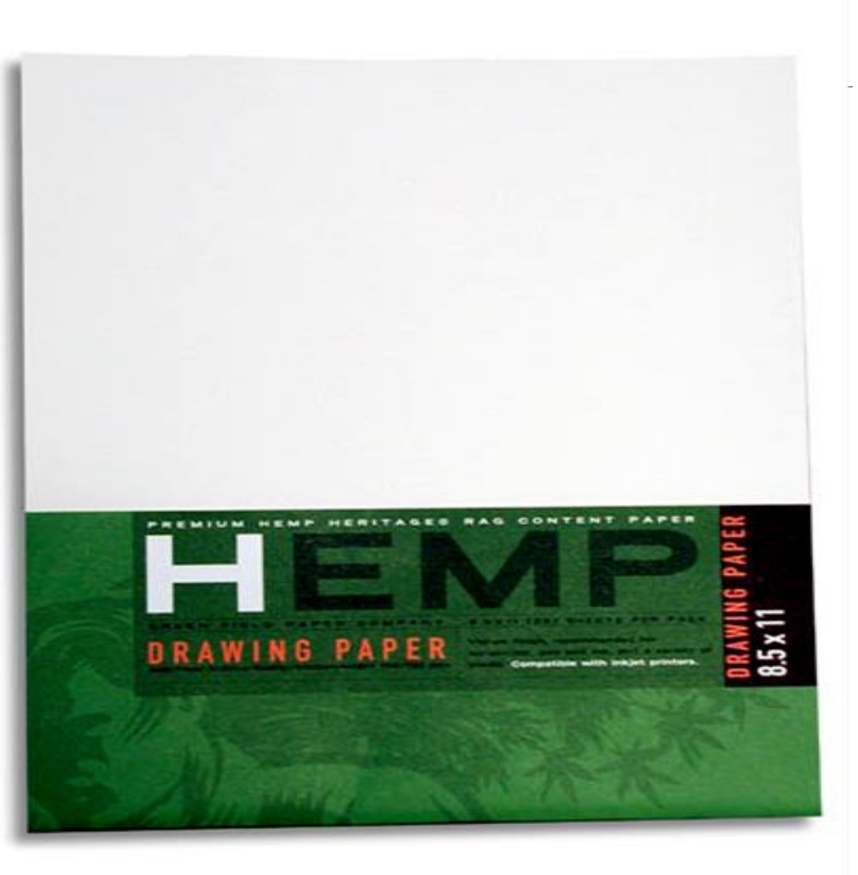
DRAWING TOOLS



9. Circle Template

10. Tissue paper

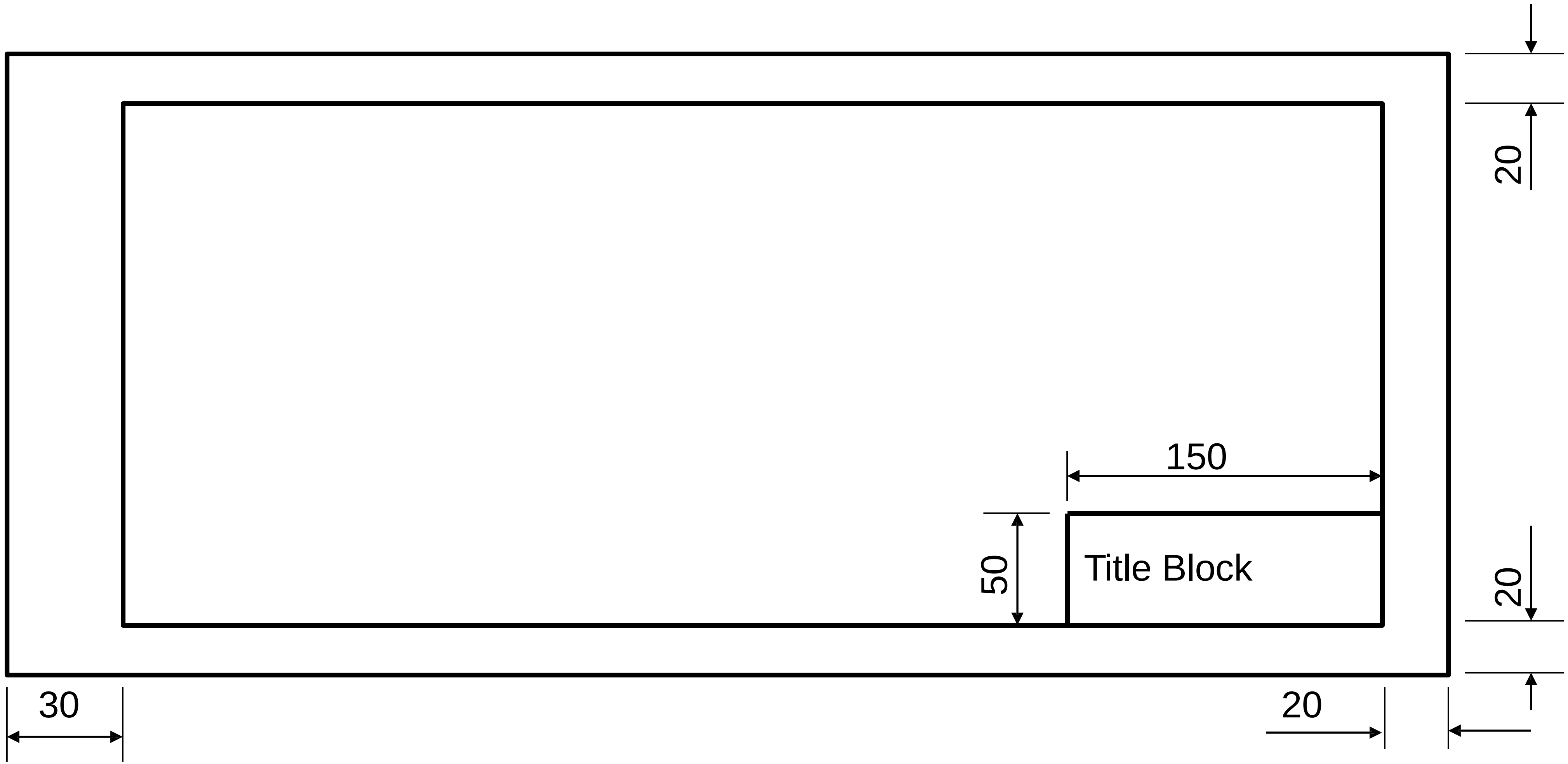
DRAWING TOOLS



11. Sharpener

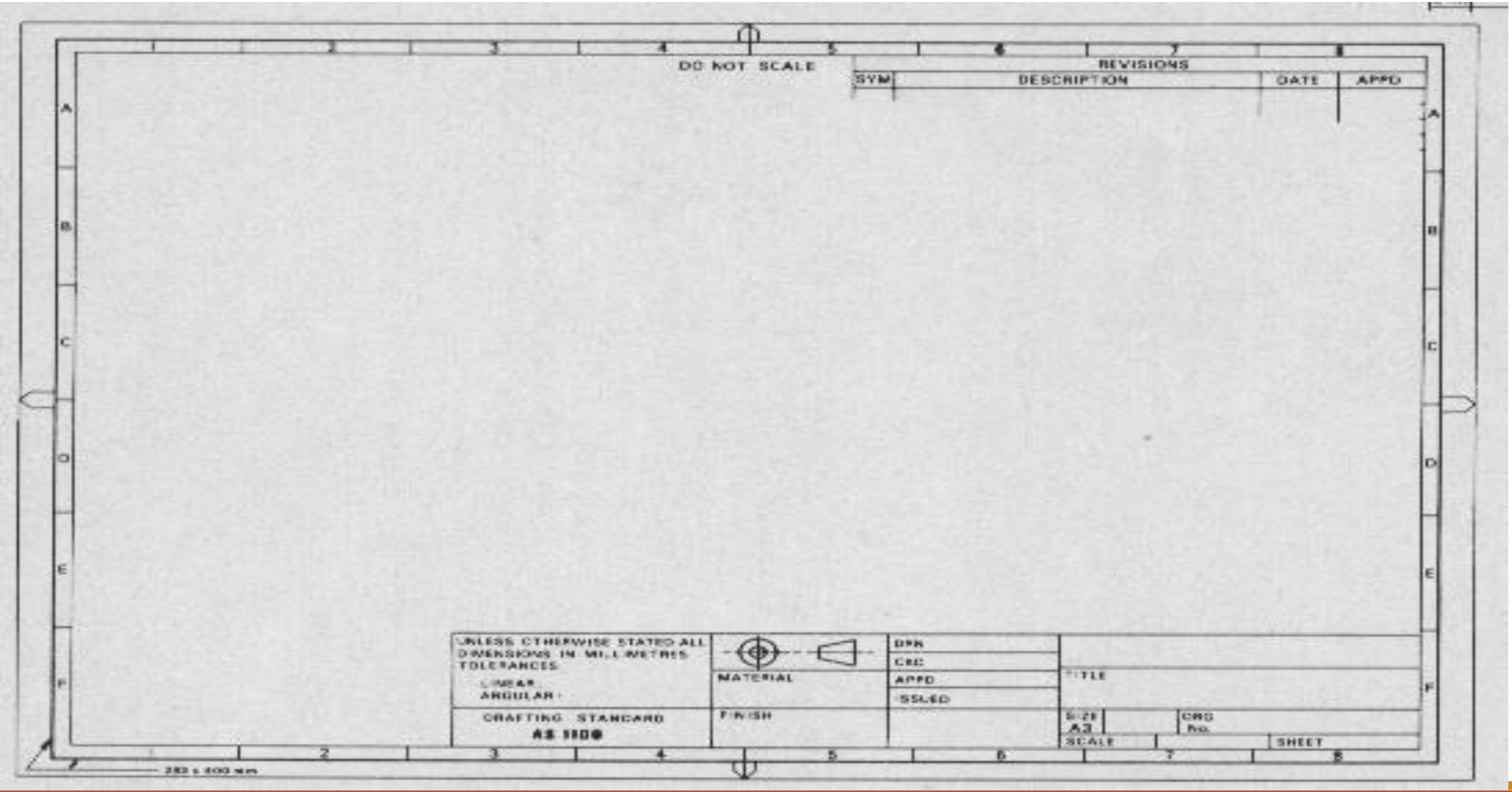
12. Clean paper

Layout of Drawing Sheet

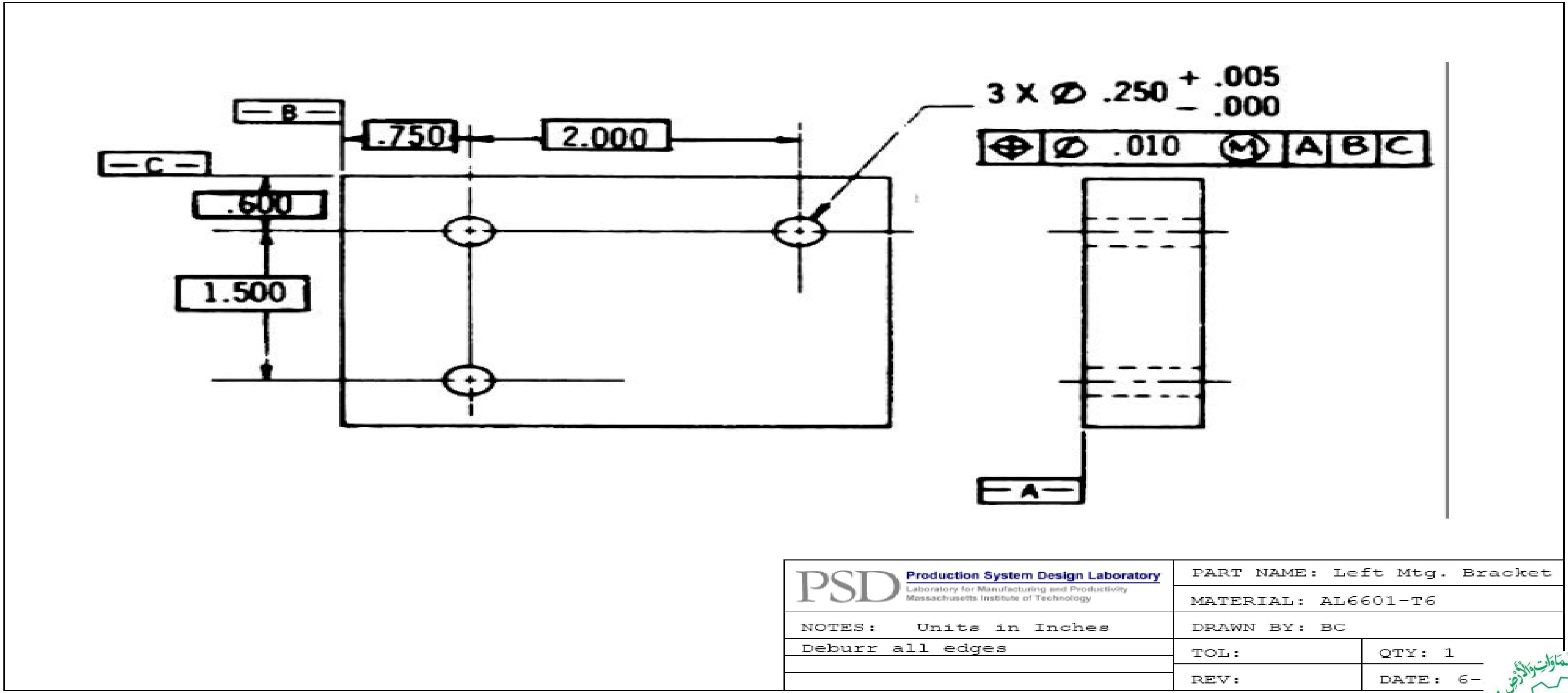


All the dimensions are in millimeters.

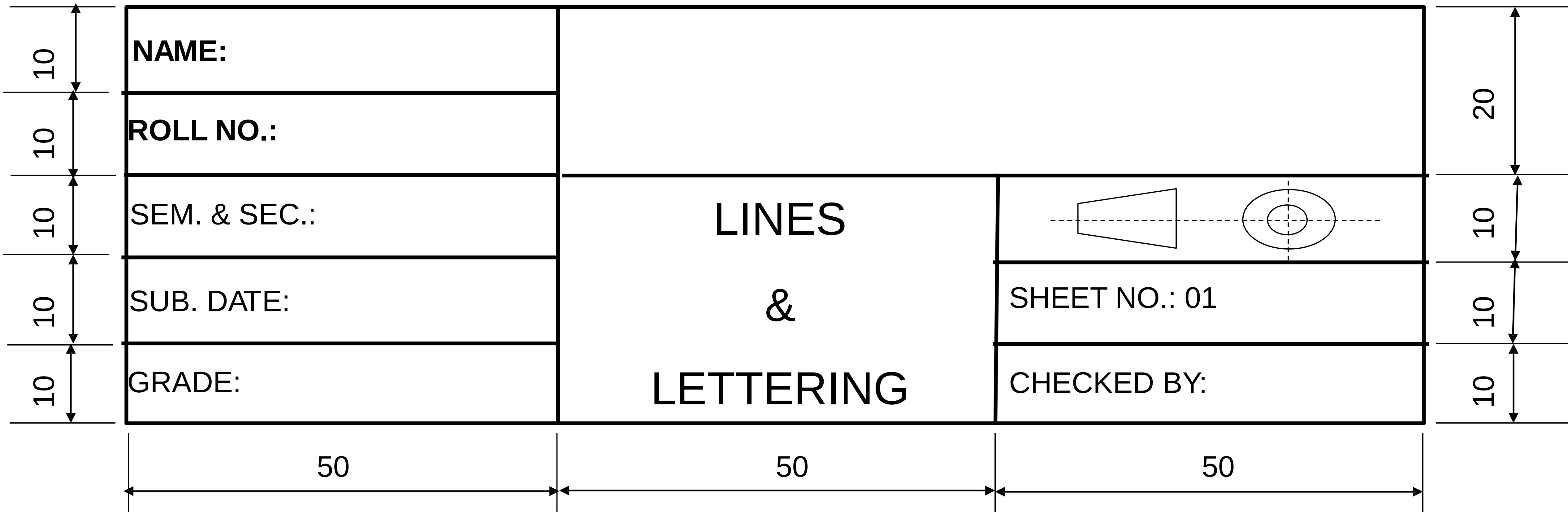
SAMPLE OF DRAWING SHEET



SAMPLE OF ENGINEERING DRAWING



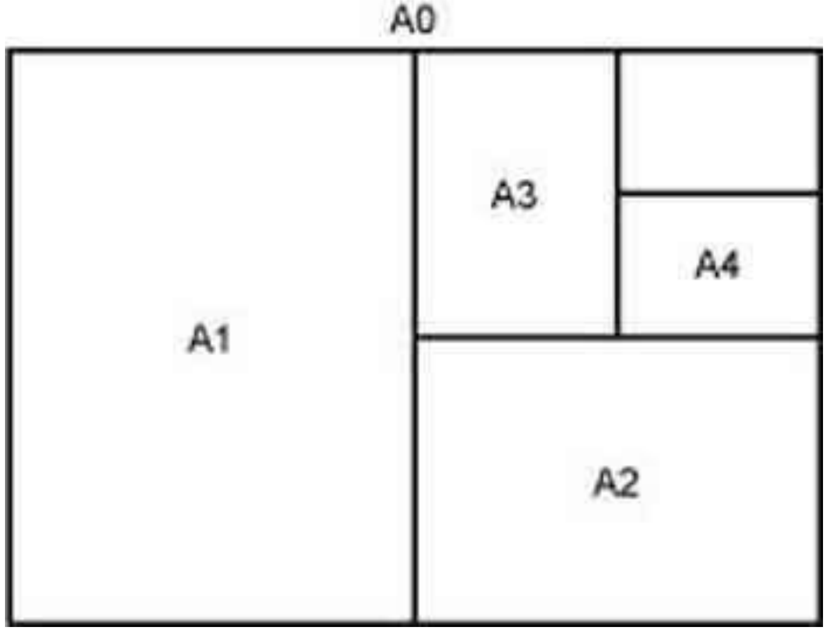
Title Block (Sample)



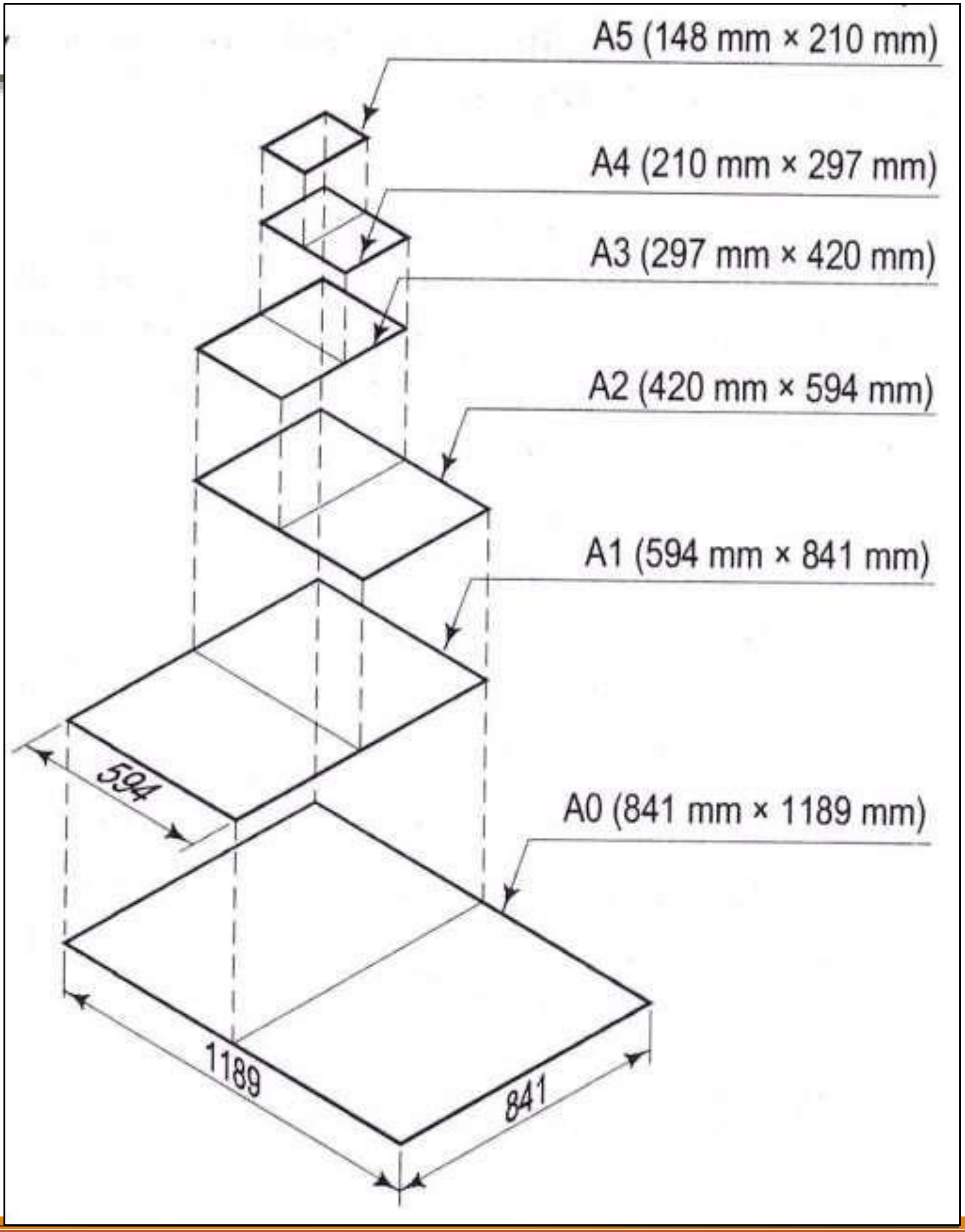
NOTES:

All the dimensions are in millimeters.

Sheet Size



Designation	Trimmed Size (mm)	Untrimmed size (mm)
A0	841 x 1189	880 x 1230
A1	594 x 841	625 x 880
A2	420 x 594	450 x 625
A3	297 x 420	330 x 450
A4	210 x 297	240 x 330



Basic Information Included in a Drawing

- Projected Views: Show as many sides as needed for completeness.
- Cross Sections: A view that is good for showing interior features.
- Table: Lower right corner, with material information, part name, designer etc.

and finally

- DIMENSIONS!!!: These are the most important and most complicated part of the drawing. There is more to it than just the numerical values!

LINES

Line Thickness:

Thickness varied according to the use of pen or pencil and the size & type of the drawing.

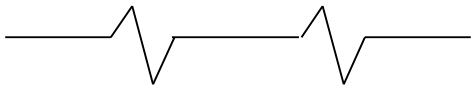
For pencil, the lines can be divided into two line-groups:

Line-group (mm)	Thickness	Lines
0.2	Medium	Out lines, dotted lines, cutting plane lines
0.1	Thin	Centre lines, section lines, dimension lines, extension lines, construction lines, leader lines, short-break lines and long-break lines.

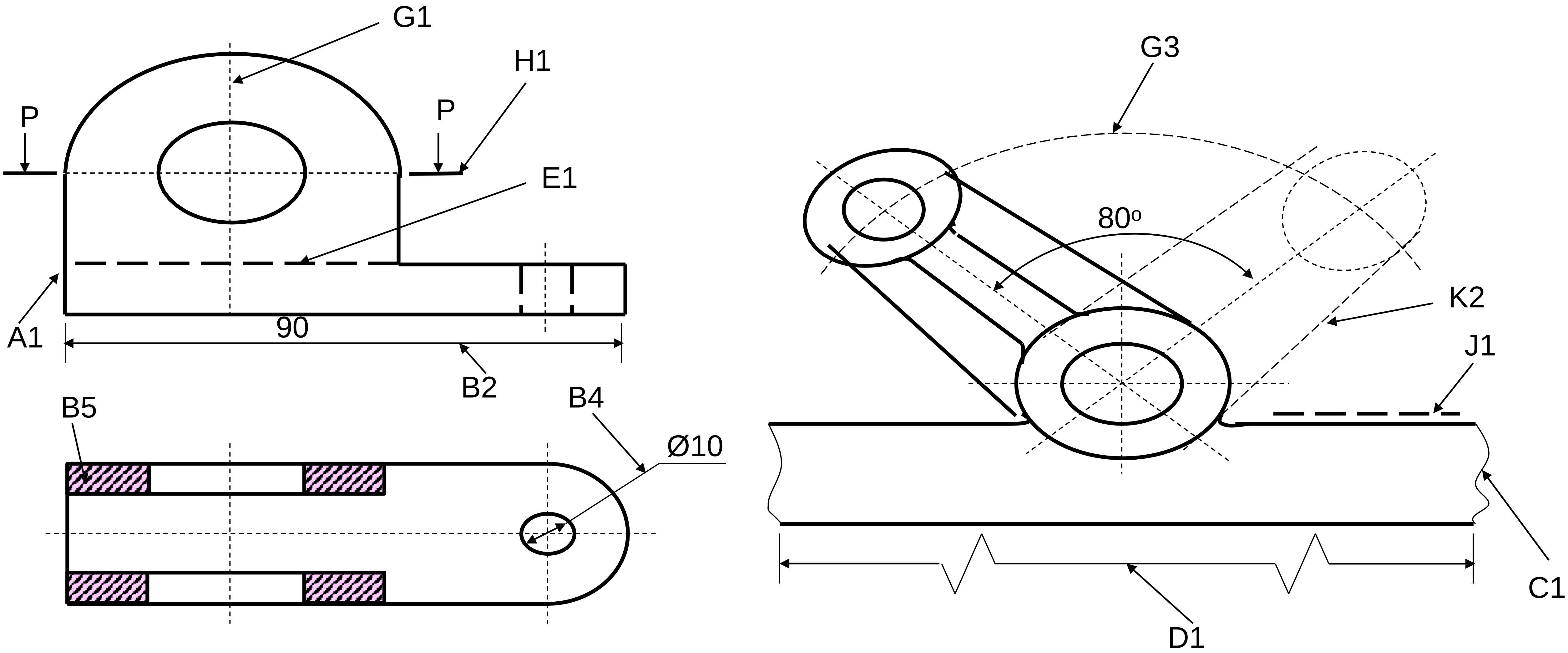
Important Notes:

In the finished drawing, all lines except construction lines should be dense, clean and uniform. Construction lines should be drawn very thin and faint and should be hardly visible.

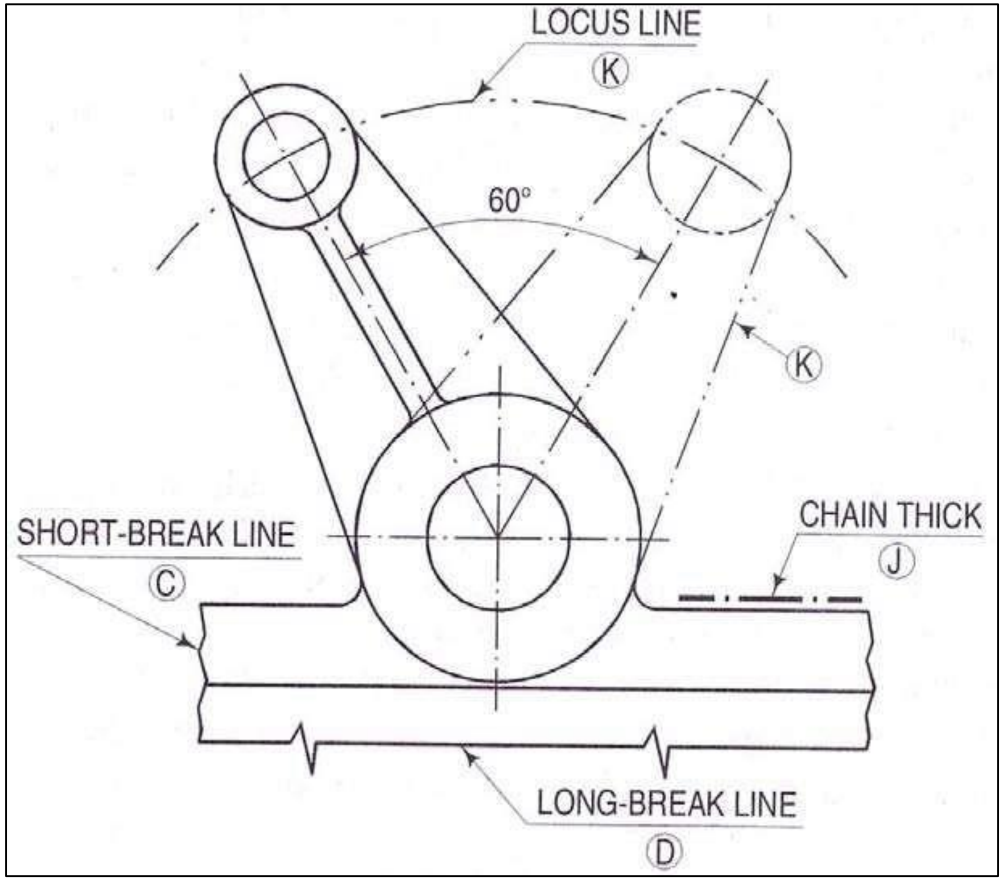
Types of Lines

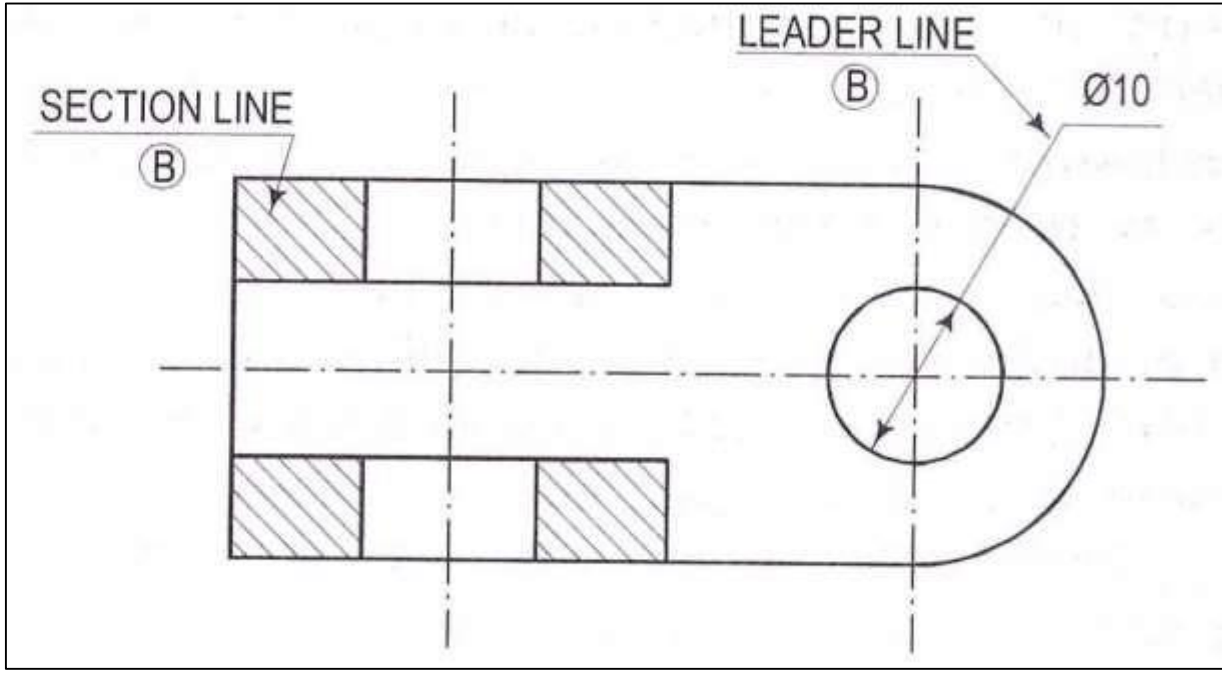
Lines		Description	General Applications	
A		Continuous thick	A1 A2	Visible outlines Visible edges
B		Continuous thin (straight / curve)	B1 B2 B3 B4 B5 B6 B7	Imaginary lines of intersection Dimension lines Projection lines Leader lines Hatching or section lines Outlines of revolved sections in plane Short centre lines
C		Continuous thin (free-hand)	C1 C2	Limits of partial or interrupted views and sections Short-break lines
D		Continuous thin (straight with zigzags)	D1	Long-break lines

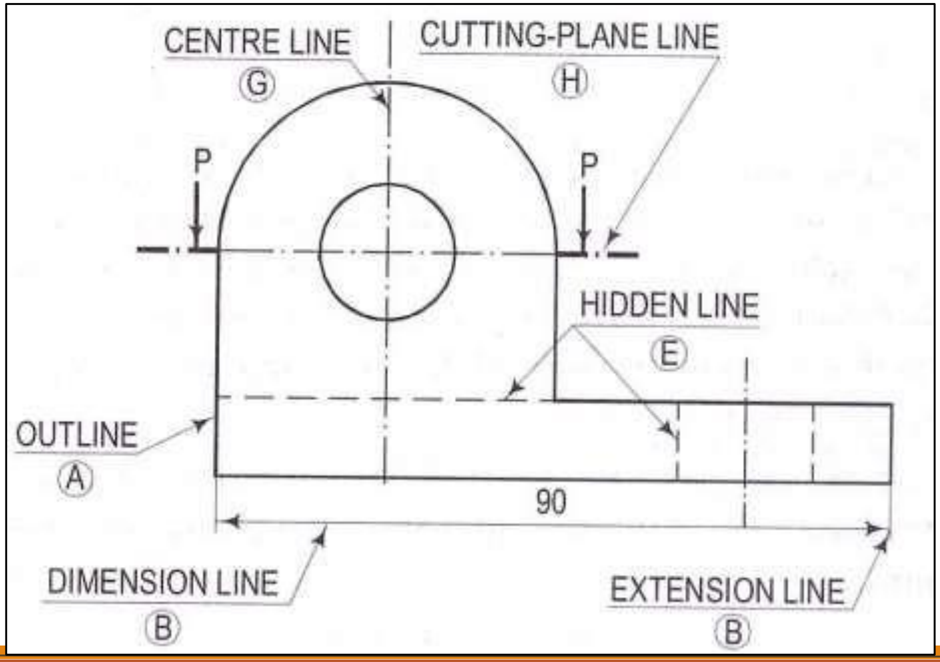
Lines		Description	General Applications	
E		Dashed thick	E1 E2	Hidden outlines Hidden edges
F		Dashed thin	F1 F2	Hidden outlines Hidden edges
G		Chain thin	G1 G2 G3	Centre lines Lines of symmetry Trajectories
H		Chain thin, thick at ends and changes of direction	H1	Cutting planes
J		Chain thick	J1	Indication of lines or surfaces to which a special treatment applies
K		Chain thin double-dashed	K1 K2 K3	Outlines of adjacent parts Alternative and extreme positions of movable parts Centroidal lines



Application of various types of lines according to B.I.S.


LOCUS LINE
K
60°
K
SHORT-BREAK LINE
C
CHAIN THICK
J
LONG-BREAK LINE
D


LEADER LINE
B
Ø10
SECTION LINE
B


CENTRE LINE
G
CUTTING-PLANE LINE
H
P
P
HIDDEN LINE
E
OUTLINE
A
90
DIMENSION LINE
B
EXTENSION LINE
B

Lettering

Writing of titles, dimensions, notes and other important particulars on a drawing is lettering

Classification:

1. **Single-stroke Letters:**

   The thickness of the line of the letter is obtained in one stroke of the pencil.

   Recommended by B.I.S.

   It has two types:

   i. Vertical

   ii. Inclined (slope 75^{o} with the horizontal)

- The ratio of height to width varies but in most of the cases it is 6:5.
- Lettering is generally done in capital letters.
- The lower-case letters are generally used in architectural drawings.

- The spacing between two letters should not be necessarily equal.
- The letters should be so placed that they do not appear too close together

  too much apart.
- The distance between the words must be uniform and at least equal to the height of the letters.
- Lettering, except the dimension figures, should be underlined to make them more prominent.

Size of Alphabets for Drawing:

Main titles ---6-8 mm

Sub titles --3-6 mm

Notes, dimension figures, etc. --------------3-5 mm

Drawing no. -----------------------------------10-12 mm d

d/2

ABCDEFGHIJKLMN
OPQRSTUVWXYZ
1234567890

abcdefghijklmnopqrstuvwxy
z

Dimensioning

The art of writing the various sizes or measurement on the finished drawing of an object.

Types of Dimensioning:

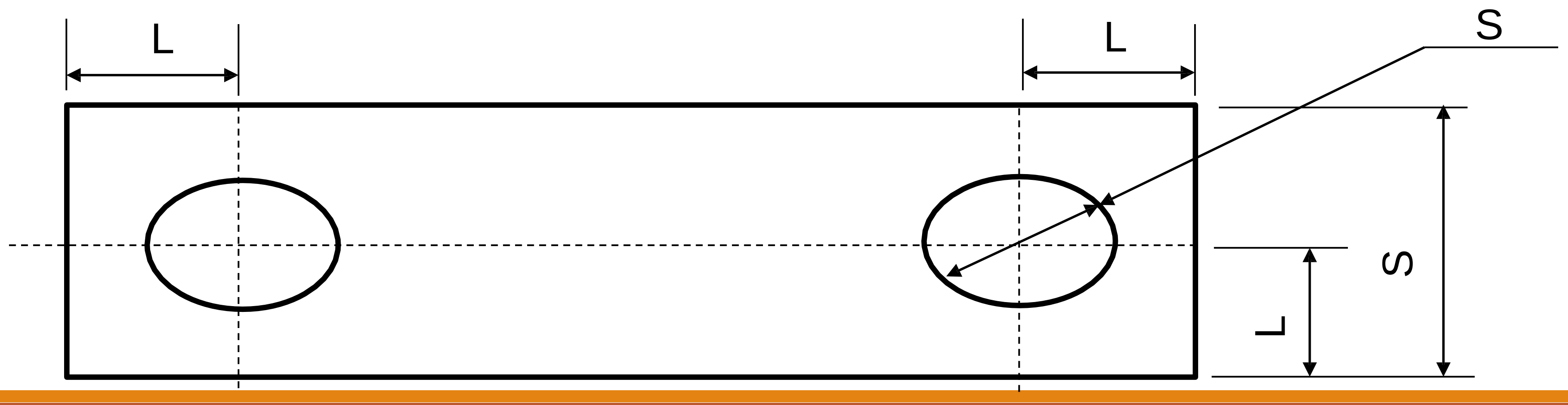
i. **Size or Functional Dimensions (S):**

It indicates sizes.

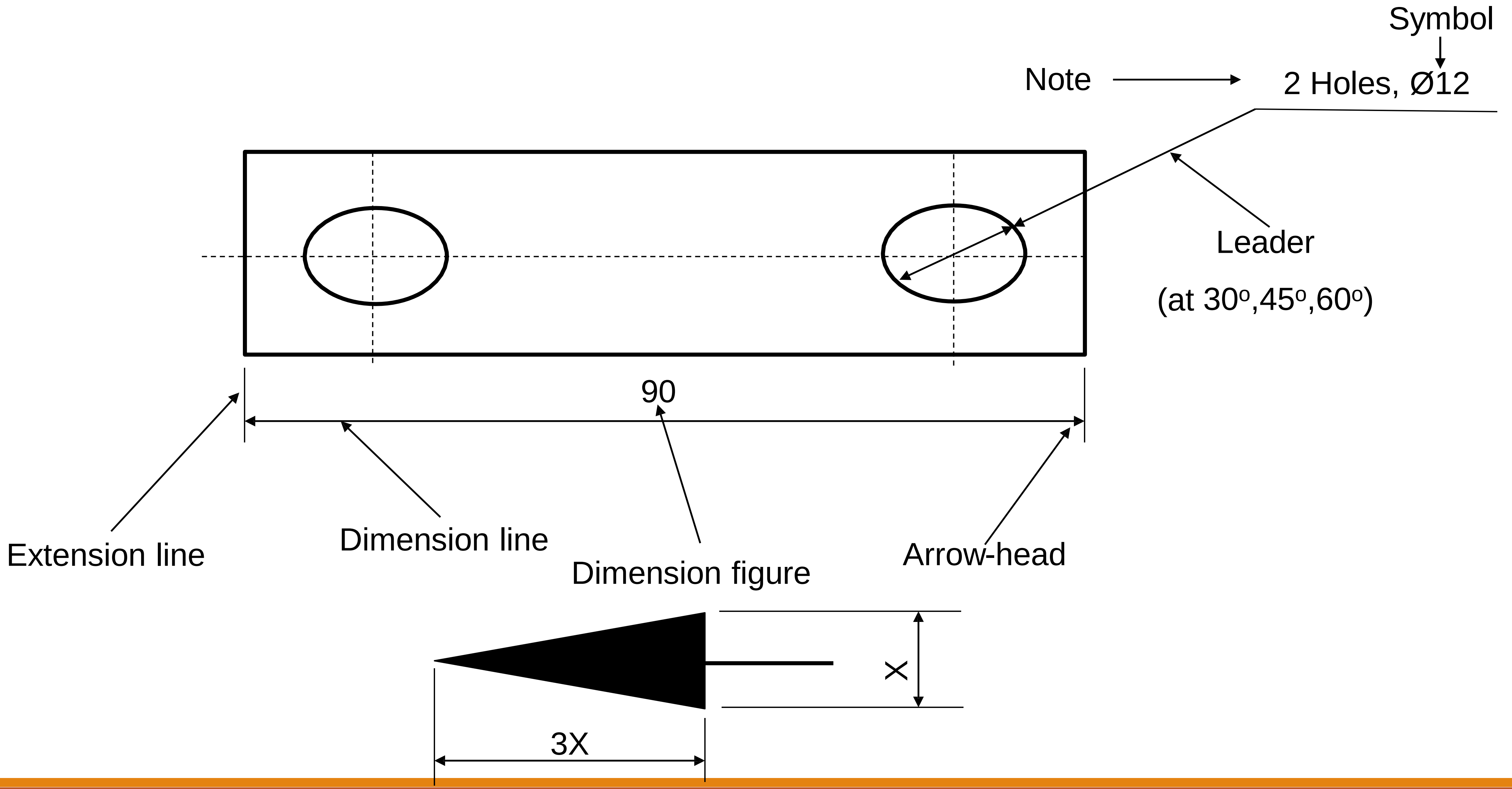
e.g. length, breadth, height, diameter, etc.

ii. **Location or Datum Dimensions (L):**

It shows location or exact position of various constructional details within the object.



Notations of Dimensioning



1. **Dimension line:**

   Thin continuous line used to indicate the measurement.

2. **Extension line:**

   Thin continuous line extending beyond the outline of the object.

3. **Arrow-head:**

   Used to terminate the dimension line. Length : width ratio is 3:1.

   Space filled up.

4. **Note:**

   Gives information regarding specific operation relating to a feature.

5. **Leader:**

   Thin continuous line connecting a note or a dimension figure with the feature to which it is applied. Terminated by arrow-head or dot.

6. **Symbol:**

   The representation of any object by some mark on the drawing.

time and labour.

Units of Dimensioning

As for as possible all dimensions should be given in millimeters omitting the abbreviation mm.

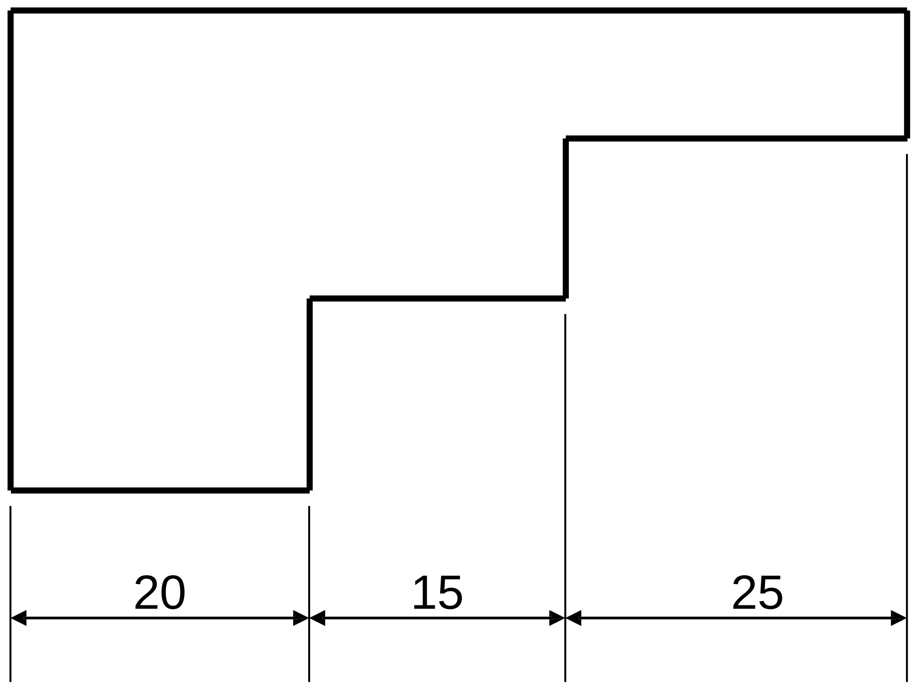
If another unit is used, only the dimension figures should be written. But a foot note such as 'All the dimensions are in centimeters' is inserted in a prominent place near the title box.

e.g. 15.50

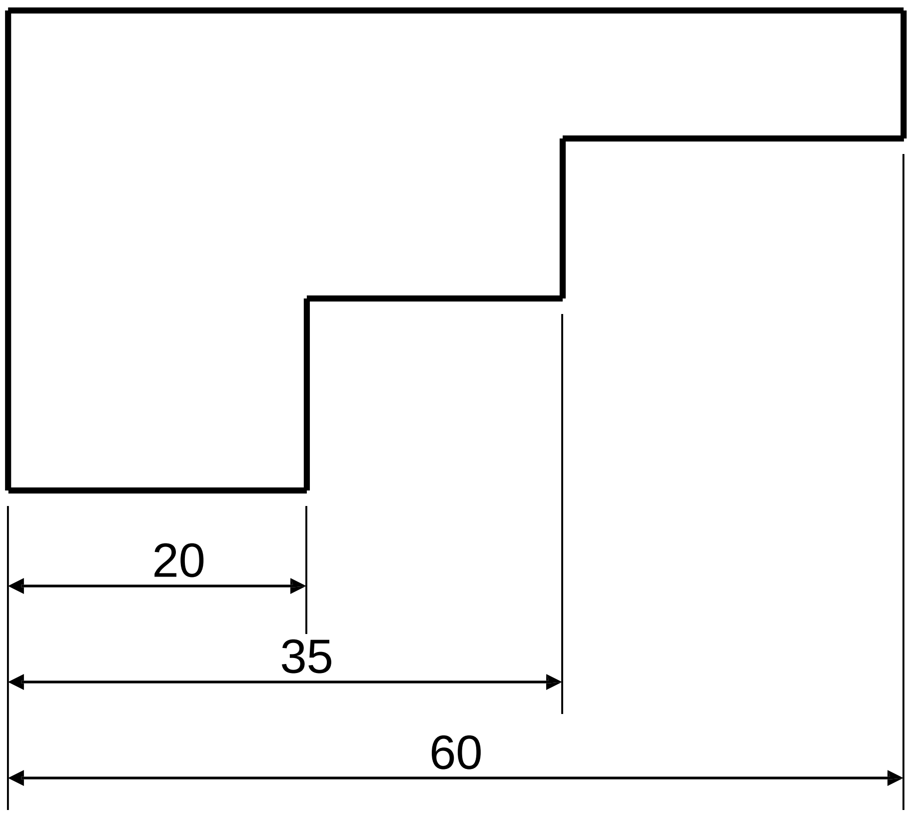
0.75 (Zero must precede the decimal point.)

15.50 ± .75 (Zero is omitted.)

The ways of Placing the Dimensions in a Series

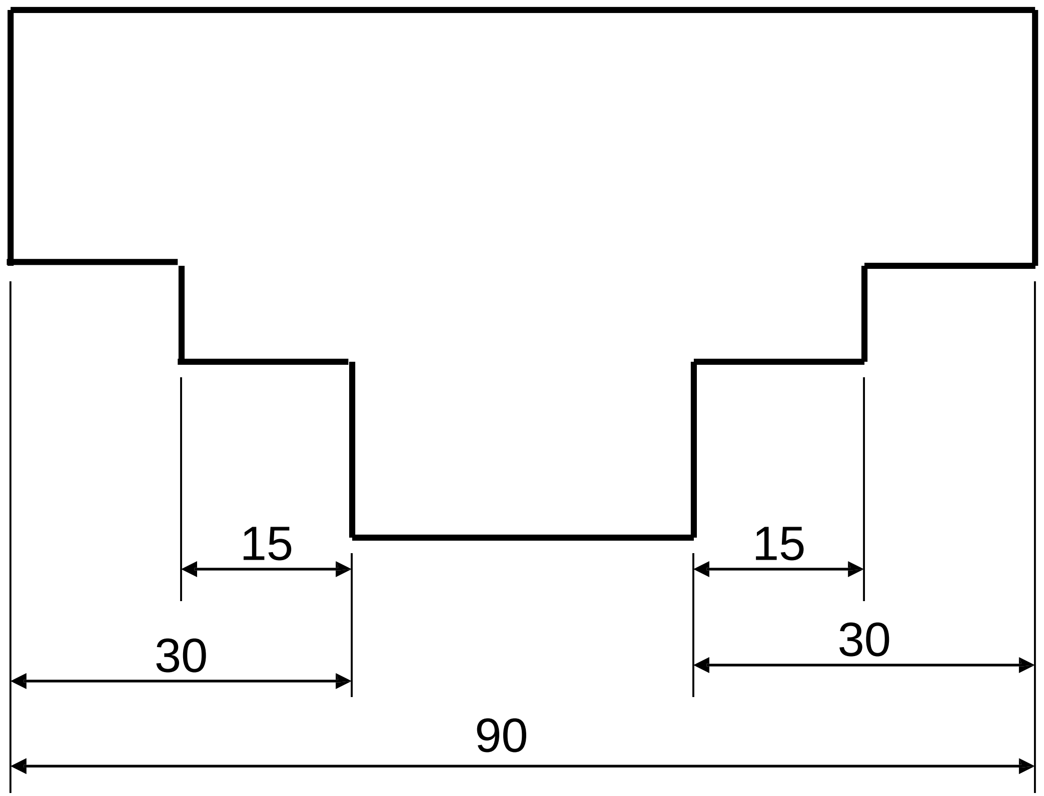


Chain

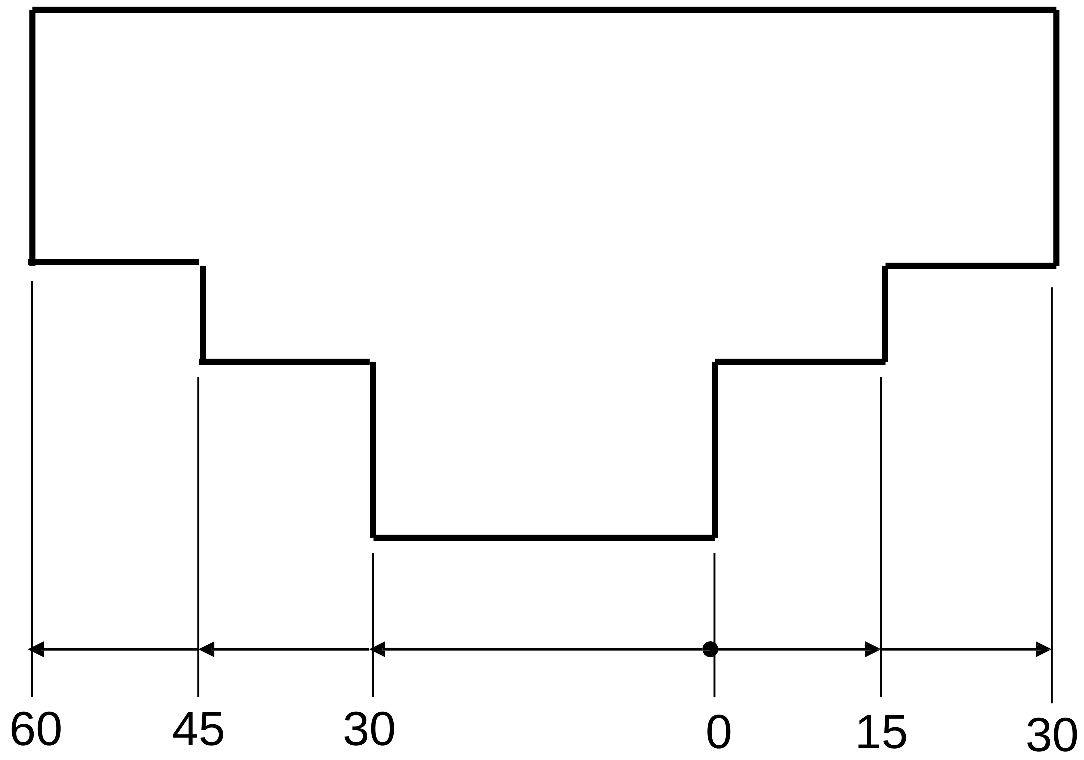


Parallel

The ways of Placing the Dimensions in a Series



Combined



Progressive

The ways of Placing the Dimensions in a Series

1. **Chain Dimensioning:**

   Dimensions are arranged in a straight line.

2. **Parallel Dimensioning:**

   All the dimensions are shown from a common base line.

   The smaller dimension is placed nearer the view.

3. **Combined Dimensioning:**

   Chain and parallel dimensioning used simultaneously.

4. **Progressive Dimensioning:**

   One datum or surface is selected which reads as zero. All the dimensions are referred to that point or surface.

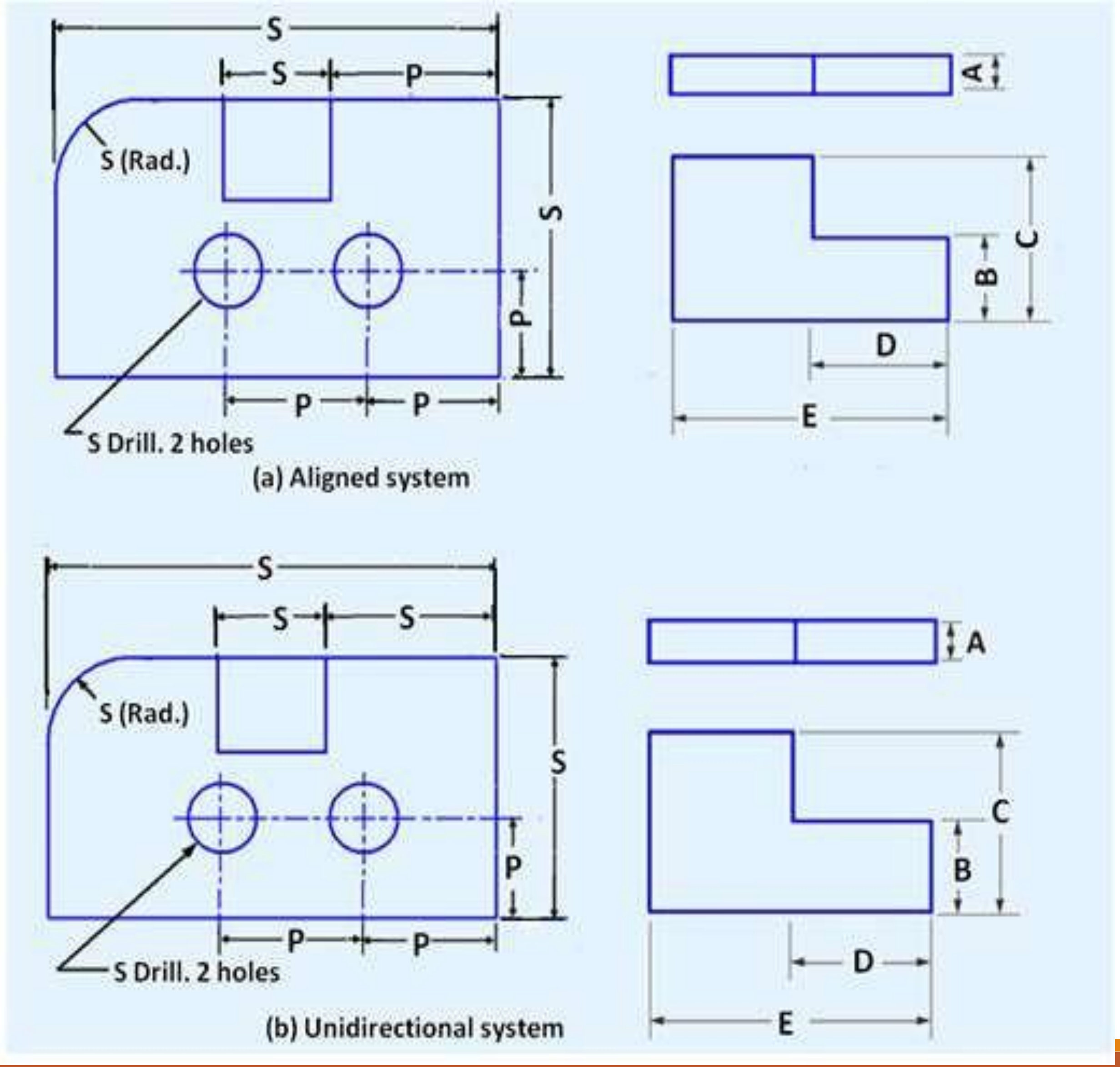
Types of Dimensioning

1. Aligned System

In the aligned system the dimensions are placed perpendicular to the dimension line in such a way that it may be read from bottom edge or right hand edge of the drawing sheet.

2. **Unidirectional System**

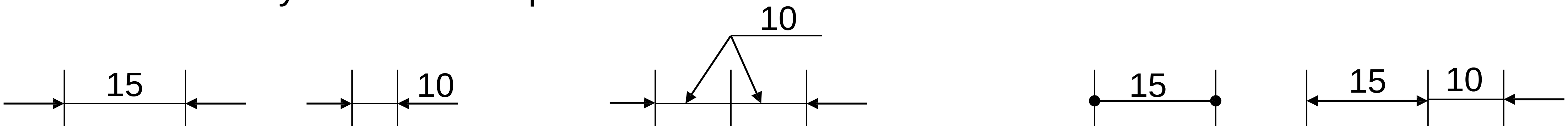
In the unidirectional system, the dimensions are so oriented such that they can be read from the bottom of the drawing.



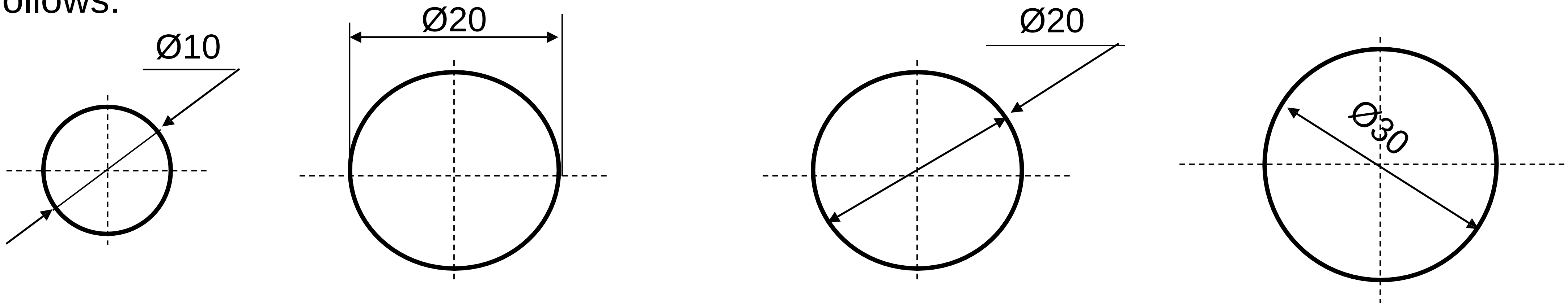
Some Important Rules for Dimensioning

1. All the dimensions necessary for the correct functioning of the part should be expressed directly on the drawing.
2. Every dimension should be given, but none should be given more than once.
3. A dimension should be placed on the view where its use is shown more clearly.
4. Dimensions should be placed outside the view, as for as possible.
5. Mutual crossing of dimension lines and dimensioning between hidden lines should be avoided. Also it should not cross any other line of the drawing.
6. An outline or a centre line should never be used as a dimension line. A centre line may be extended to serve as an extension line.
7. Aligned system of dimensioning is recommended.
8. Dimension lines should be drawn at least 8 mm away from the outlines and from each other.
9. The extension line should be extended by about 3 mm beyond the dimension line.

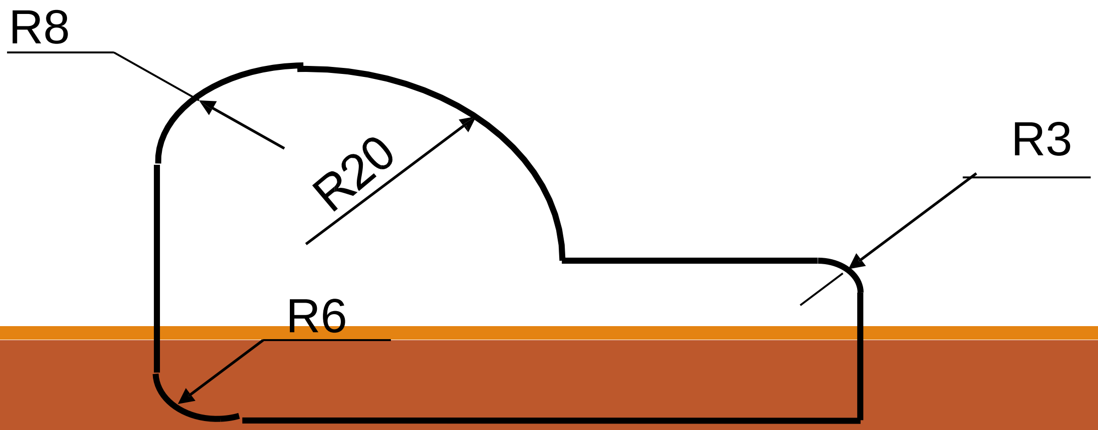
10. When the space is too narrow, the arrow-head may be placed outside. Also a dot may be used to replace an arrow-head.



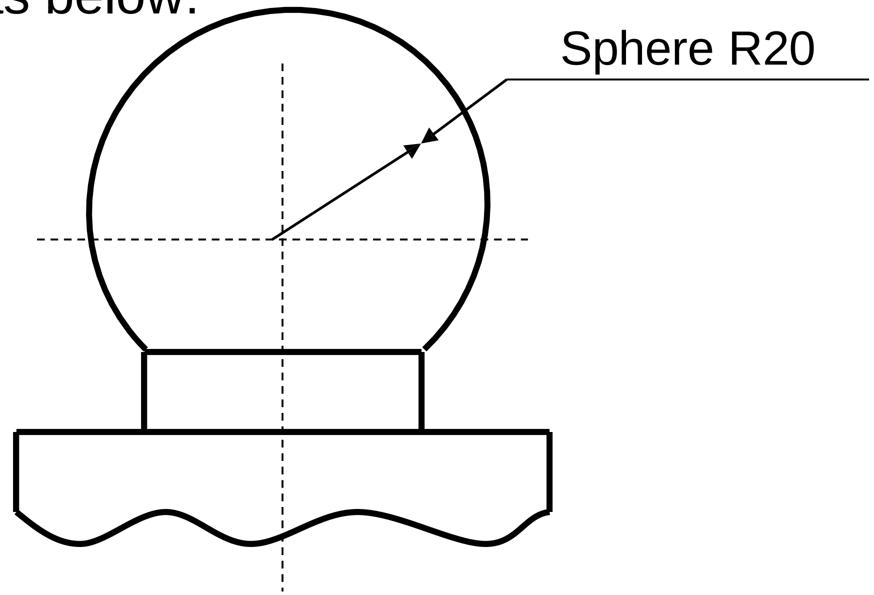
11. The various methods of dimensioning different sizes of circles are as follows:

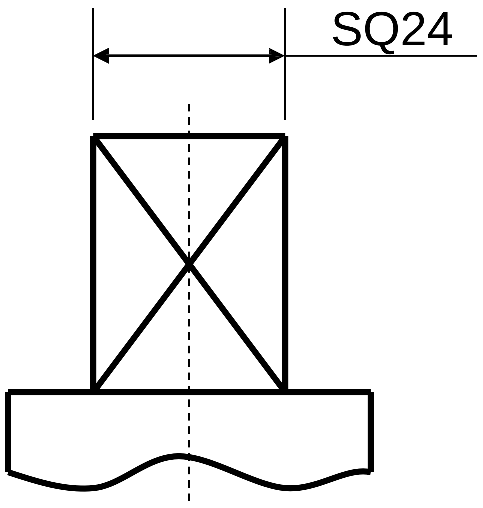


12. Arcs of circles should be dimensioned by their respective radii.

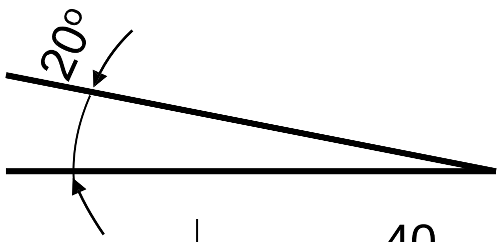


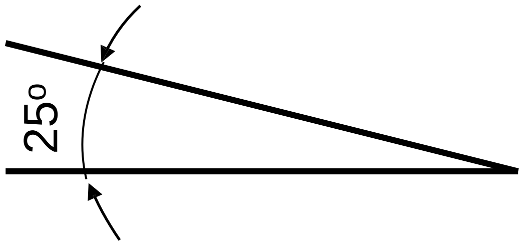
13. Radii of a spherical surface and square cross section of a rod is shown as below:

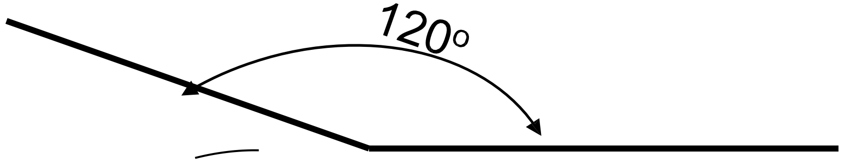


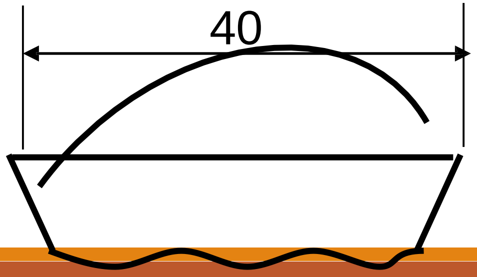


14. Angular dimension may be given as follows:

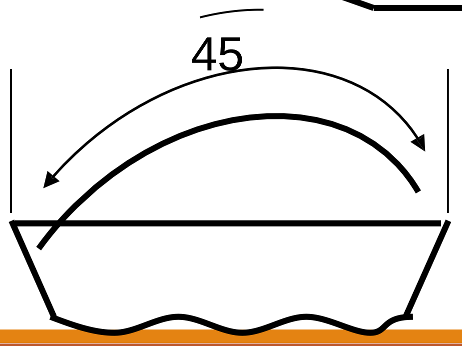






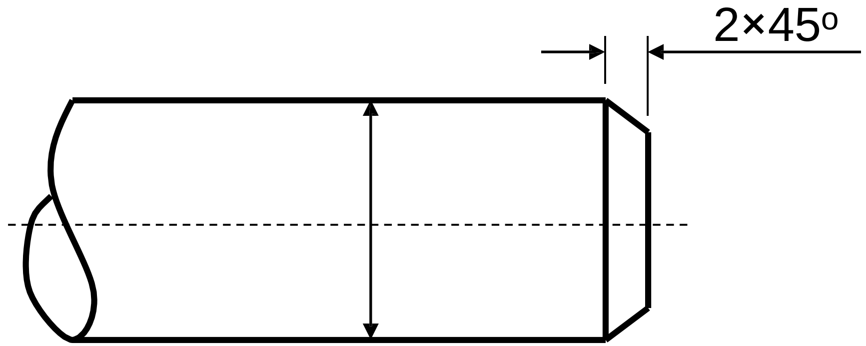


Length of Chord

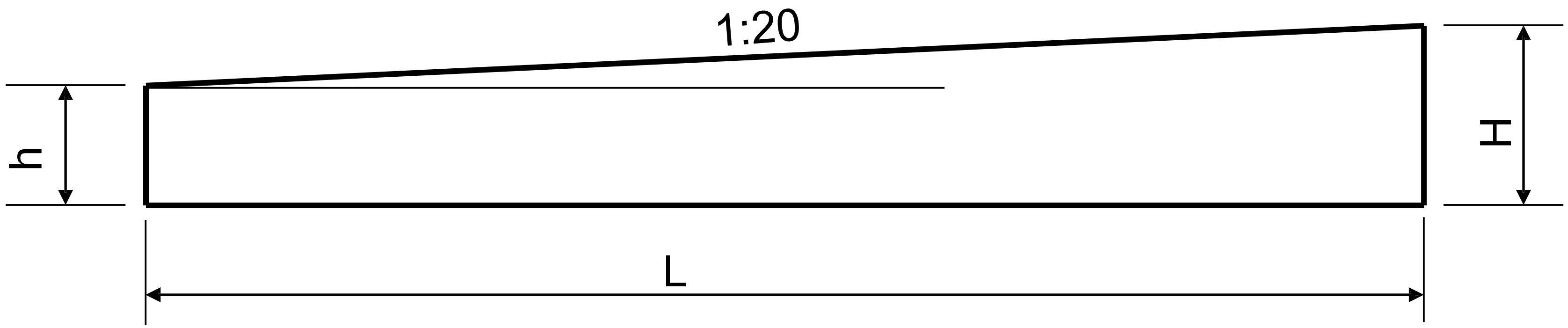


of Arc

15. Method of dimensioning of Chamfer:



16. Dimensioning of Tapered Surface:



Slope or Taper = (H-h)/L