Engineering Graphics
GET 215

Required Text Book

- Engineering Graphics for Diploma Students, Eastern Economy Edition, K. C. John, PHI Learning Private Limited, New Delhi.

Equipment Lists

- Drawing Paper and pencils,
- T-Square and Triangles,
- Compass,
- Dividers,
- French Curves,
- Drawing board.

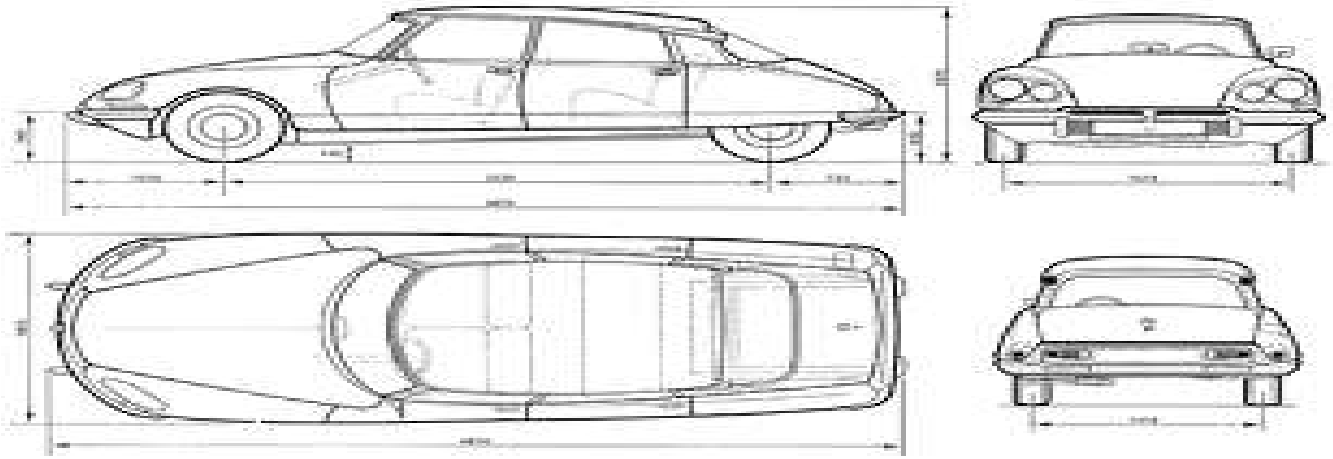
Course Evaluation

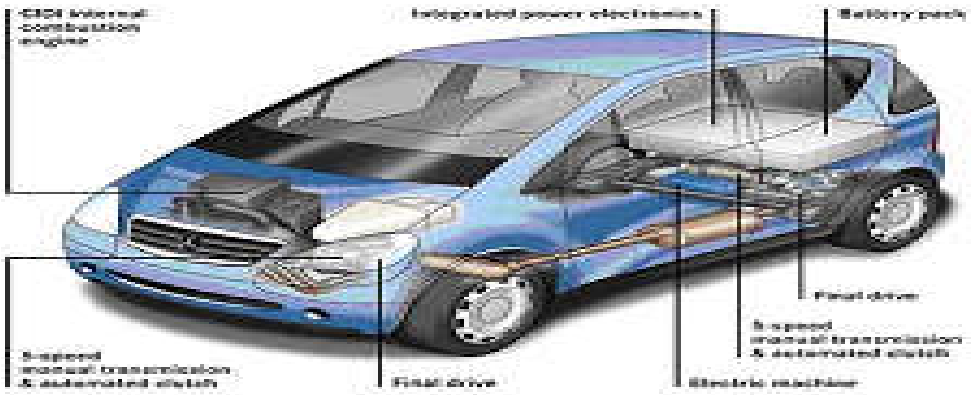
• Class Work	10%
• Assignments	10%
• Tests	20%
• Final Exam	60%
• Total	100%

What is Engineering Graphics?

- **Engineering Graphics is:**
- The principal method of communication in the Engineering profession.
- It is the global language used by designers, technicians, and engineers to design, and construct details of engineering components.
- It is the representation of physical objects and their relationships.
- It is writing in the form of drawings, using straight and curved lines to represent the shape, size, and specification of physical objects.

What is Engineering Graphics?





What is Engineering Graphics

- It is read by interpreting the drawings so that the physical objects can be constructed exactly as conceived by the designer.
- It has its own rules which are governed by codes of practice.
- An engineer (mechanical, electrical, civil, aerospace, materials, chemical e.t.c.) must possess a grasp of the theory of projection, dimensioning, and conventions related to Engineering Graphics if he or she is to become professionally efficient.

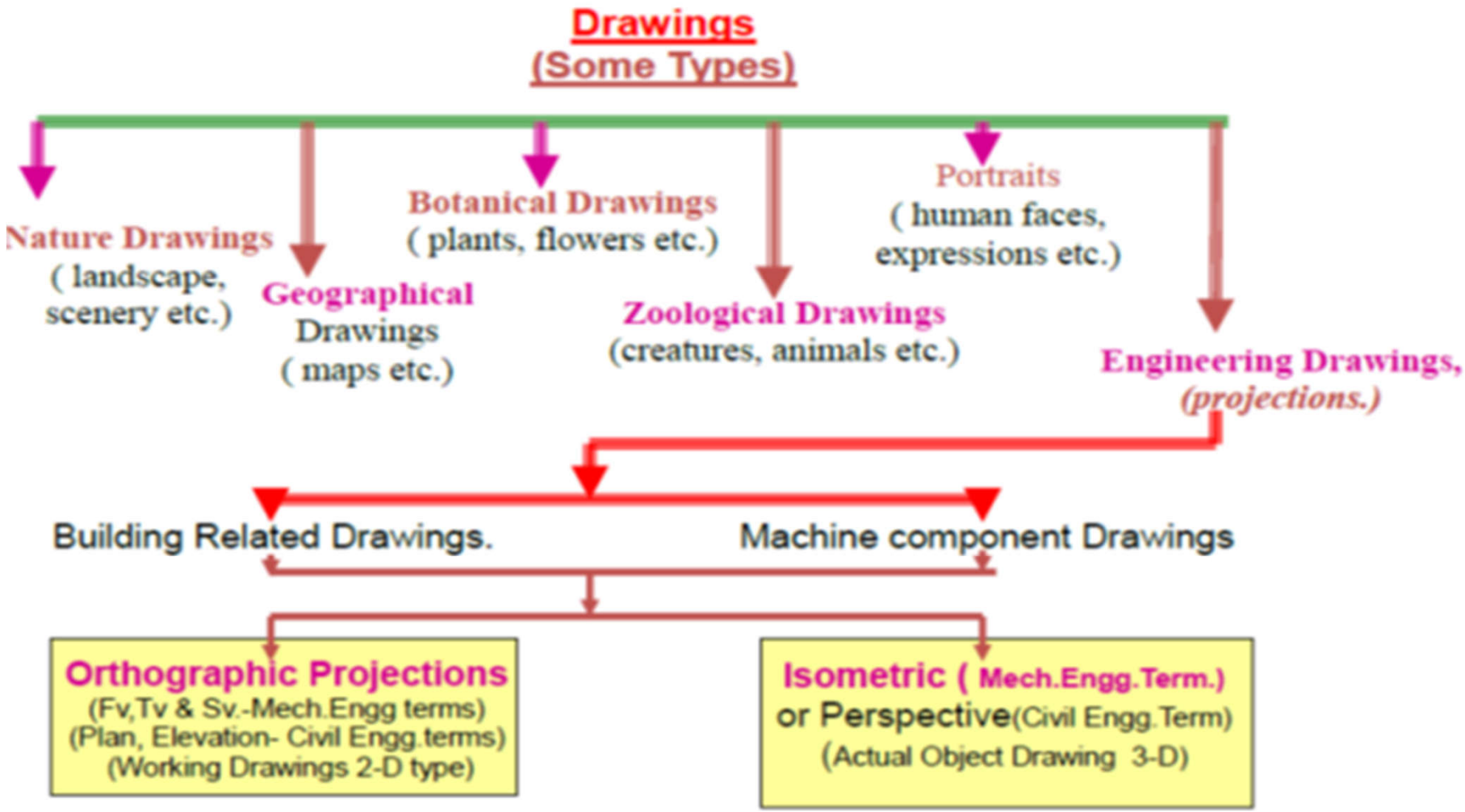
Computer-Aided Drafting (CAD)

- In computer-Aided Drafting (CAD), the drawings are prepared using the computer software and the hardware.
- In comparison to the traditional drafting, CAD is faster as well as efficient and the modifications can be effected very easily.
- In modern industries, the traditional drafting is being replaced by CAD.

Computer-Aided Drafting (CAD)

- It is important that engineers are trained in the traditional drafting first before they are exposed to CAD systems.
- This is important that they may have the expertise in operating the CAD system to develop the skill and speed for excellent performance.

Types of Drawing



Application of Engineering Graphics in Producing Components for everyday use

- Conceptual ideas creation to satisfy a particular need
- Refinement of ideas
- Design
- Drafting and detailing
- Assembly drawing
- Stage by stage manufacturing drawing
- Stage by stage inspection drawing
- Importance of drawing in advertisement and educating the customers

Engineering Graphics Instruments and their Use

- The following are the list of drawing instruments required for preparing Engineering Graphics:
  - Drawing board
  - T-square
  - Instrument box containing long compass, spring bow compass, small bow divider e.t.c.
  - Set-squares (45^o, and $30 – 60^o$) and protractor
  - Engineer’s scale and steel rule (30 cm)

Engineering Graphics Instruments and their Use (Contd.)

- Drawing pencils (standard and clutch pencils)
- Eraser
- Adhesive tape, drawing pins or clips
- Pencil sharpener or blade
- Handkerchief, duster, or dusting brush
- Letter stencils, French curves, erasing shield, and templates.

Engineering Graphics Instruments

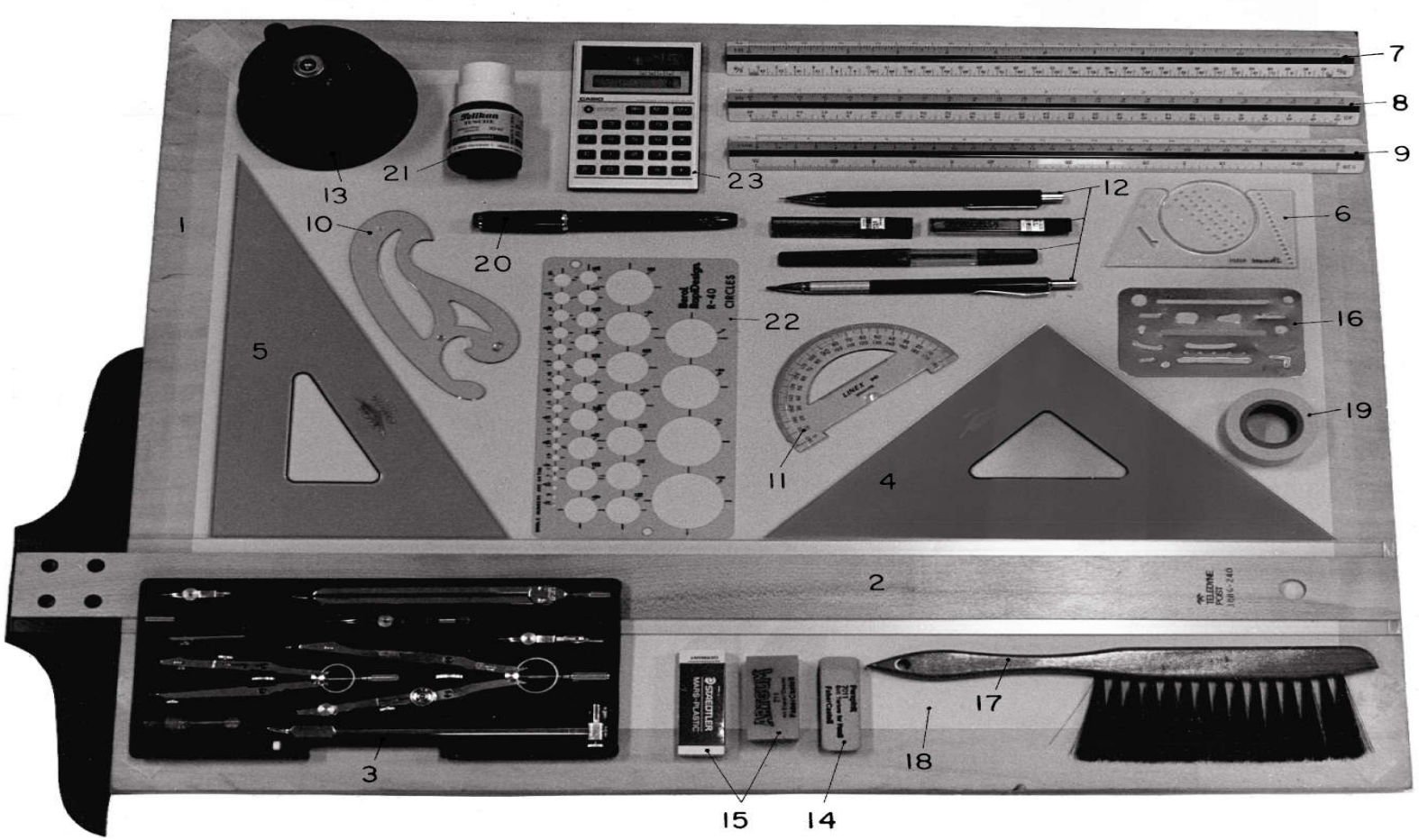
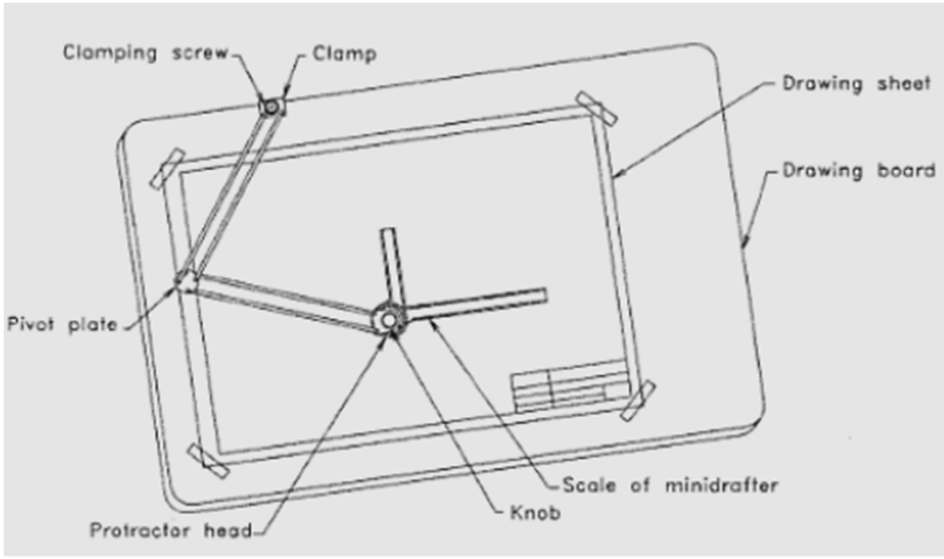


Figure 3-1

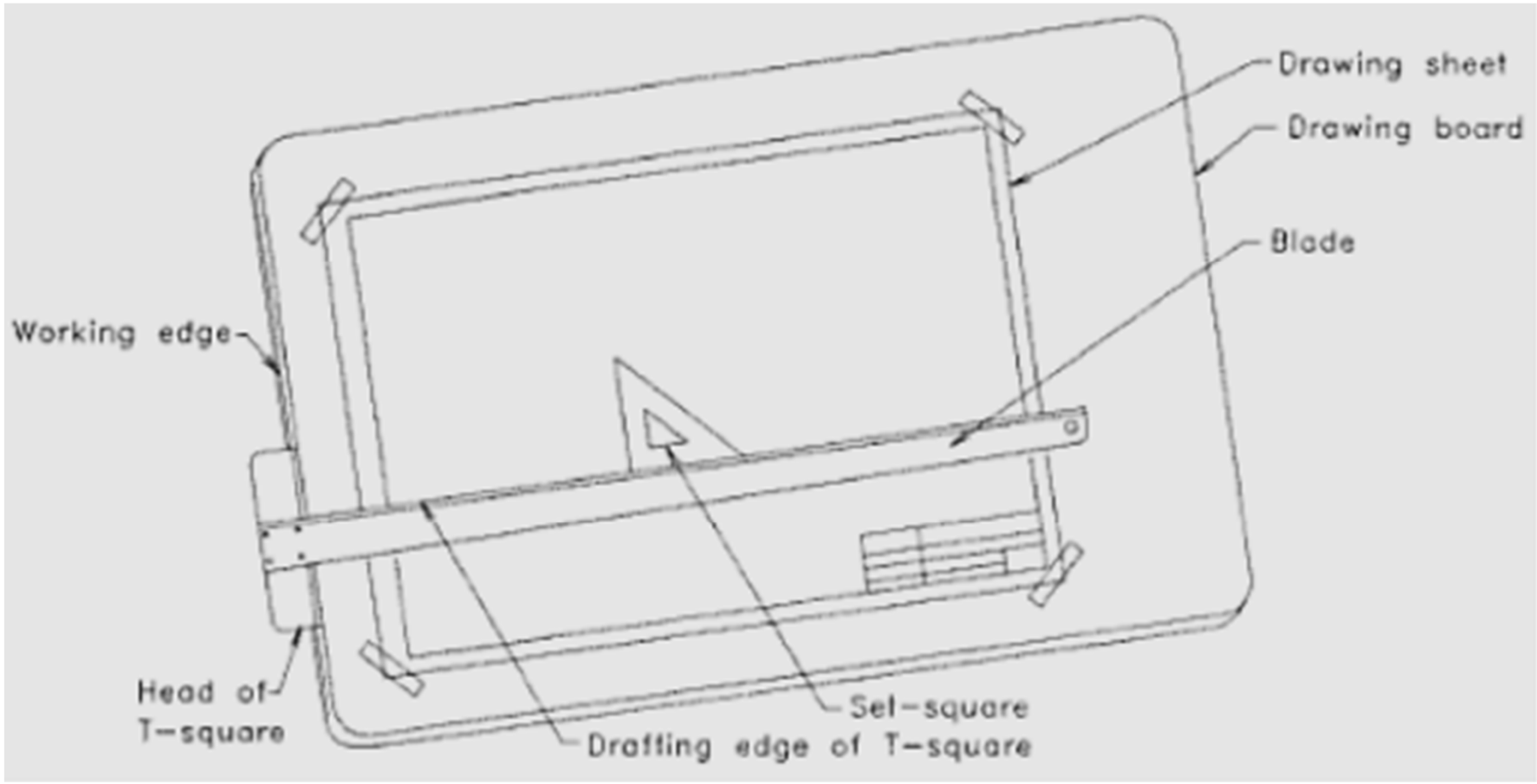
Principal Items of Equipment.

Drawing Board

- It is used for traditional drafting
- Figure 1.3 shows a drawing board with a minidrafter clamped in position.



Drafting board with T-square in drawing position.



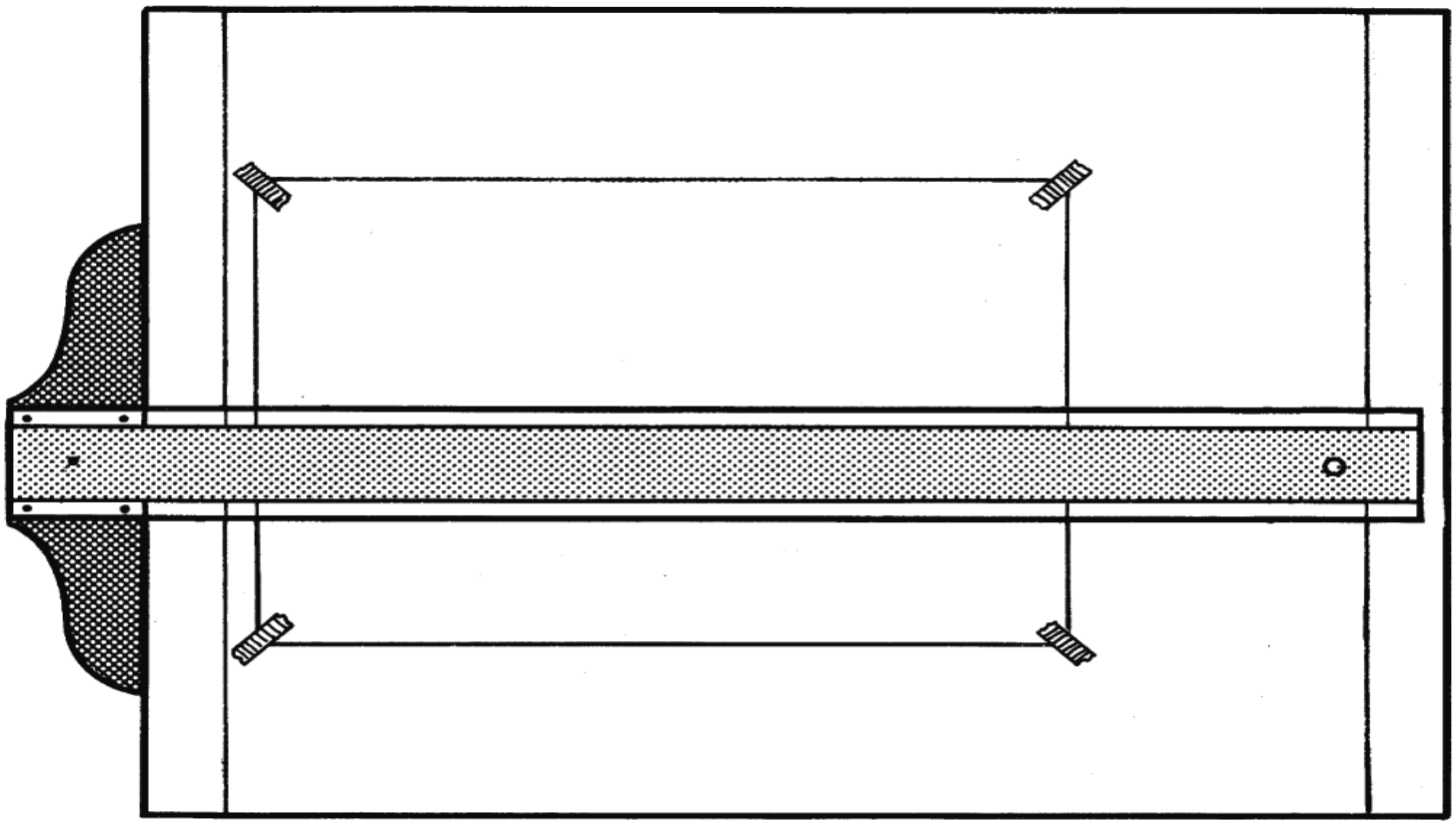


Figure 3-5

Placing Paper on Drawing Board.

T-square

- It has a long strip called blade fixed rigidly by screws at right angles to a shorter strip called head (stock).
- Figure 1.4 shows a T-square placed on a drawing board in its drawing position.
- T-square are made of either wood or plastic.
- For wooden T-squares, the top drawing side of the blade and the inner sliding slide of the stock are fitted with straight edges of hardwood.

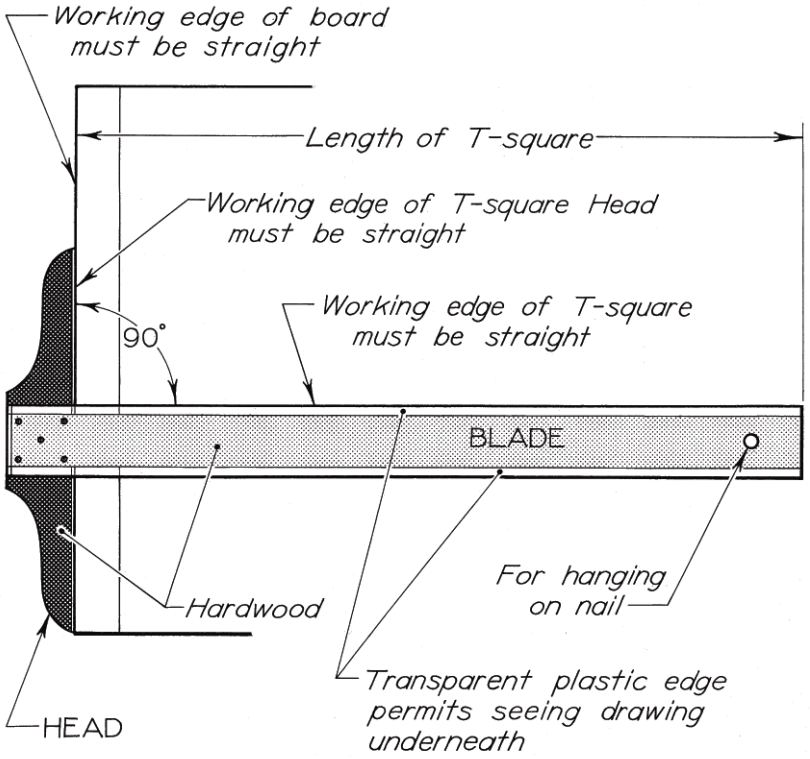


Figure 3-2

The T-square.

T-Square

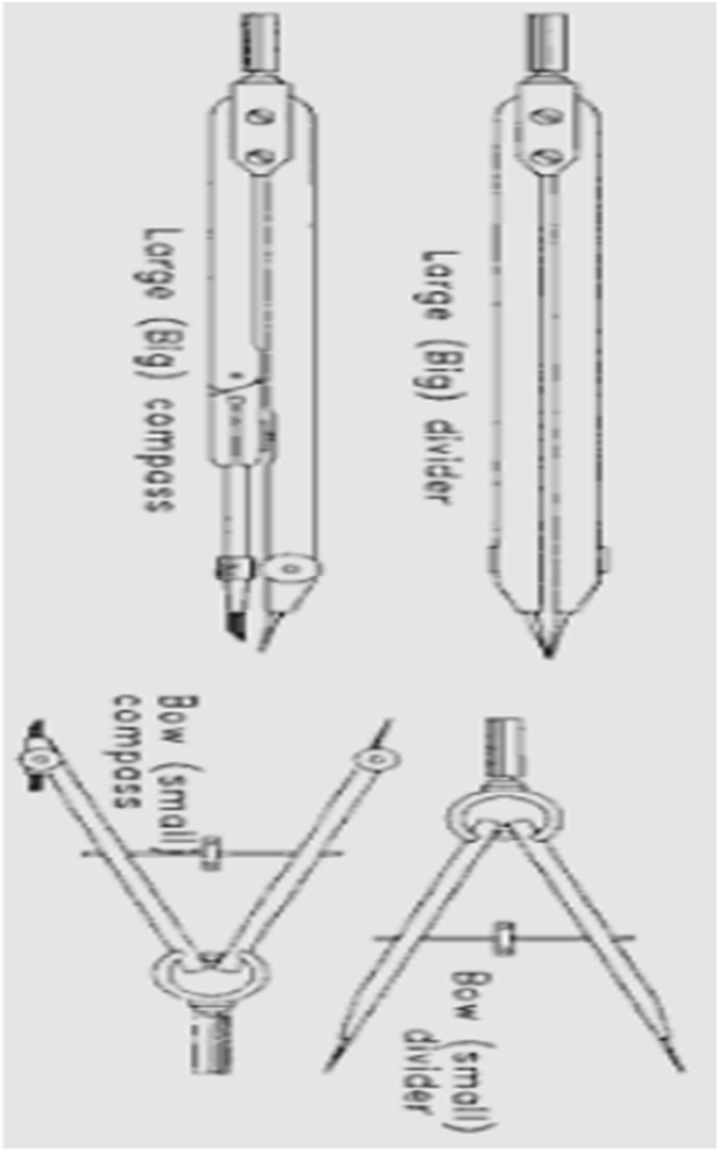
- To use the T-square, its stock is kept perfectly touching on the working edge and is moved forward and backward by left hand so that different horizontal positions of the drafting edge are obtained for drawing.
- In comparison to minidrafter, T-square gives better accuracy in large size drawings, but the speed of drafting is slow.
- For small size drawings as well as for study purpose the use of minidrafter is recommended.

Instrument Box

- This contains:
  - Large size compass
  - Lengthening bar for large size compass
  - Small bow compass
  - Large size divider
  - Small bow divider
  - Small bow ink-pen
  - Inking pens

Types of compasses and dividers

- Figure 1.5 shows types of compasses and dividers.
- Inking-pens and bow ink-pen are used for tracing of drawings with ink.
- The large size compass is used to draw large size circles and arcs.
- A pointed needle is fitted at one leg while a pencil lead is inserted in the other leg.

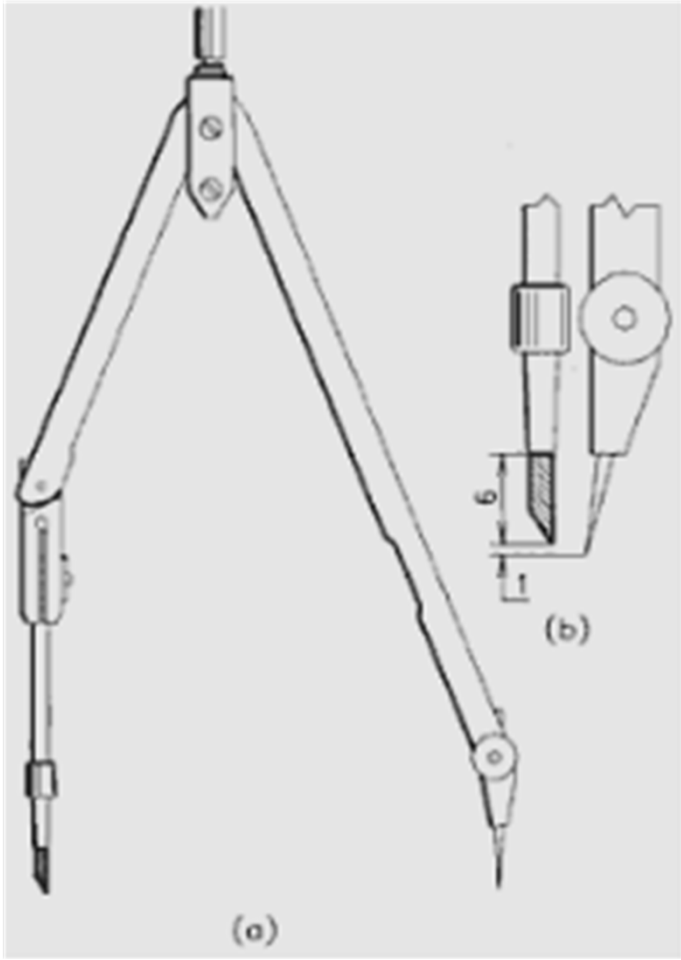


Types of compasses and dividers

- Both legs are provided with knee joints that while drawing circles or arcs of radius above 60 mm, they can be bent to keep the lead and the pointed need almost perpendicular to the surface of the drawing sheet (Figure 1.6a).

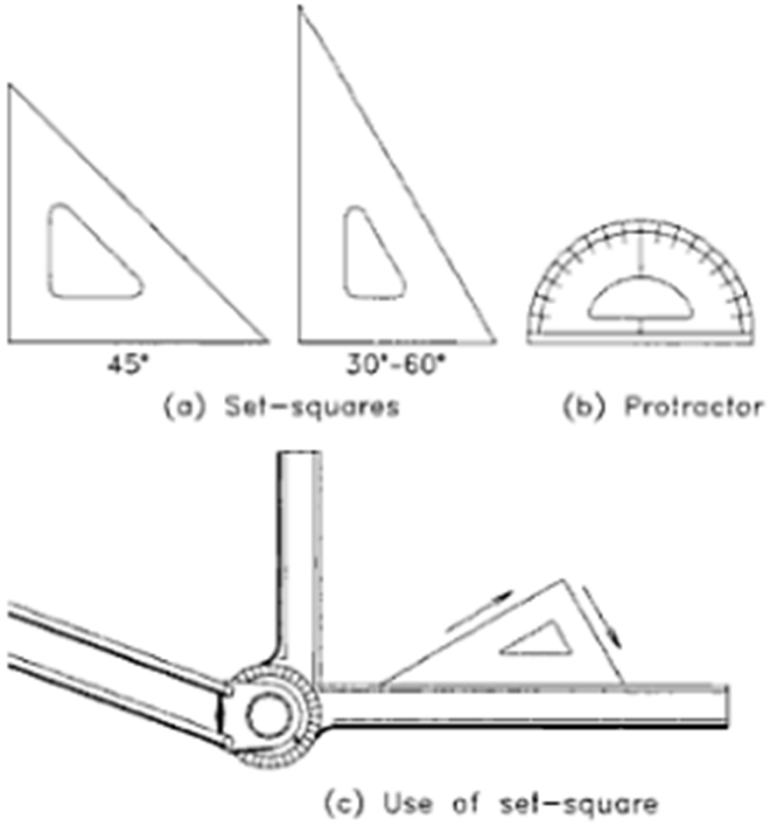
Use of large compass

- To draw arcs and circles of radius 180 mm and above, the lengthening bar is to be added to the leg, holding the lead.
- Circles and arcs of radius less than 15 mm are drawn, using small bow compass.
- The lead tip of a compass has to be sharpened and set as shown in Figure 1.6b.
- The large size divider is used to divide curved lines or straight lines into desired number of equal parts.
- They are used to transfer a length from the scale to the drawing sheet or to transfer a length from drawing sheet to the scale for measurement.
- Small bow divider is used as the large divider for shorter lengths below 20 mm.
- Inking pens and bow pens are used for tracing of drawings with ink.



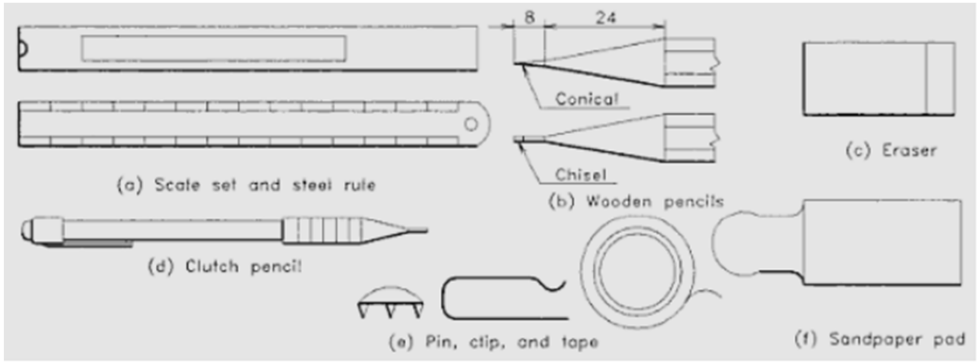
Set-squares and protractor

- Set-squares (triangles) and protractor are made of transparent plastic materials (Figure 1.7).
- Set-squares (45^o, and $30 – 60^o$) are used to draw vertical as well as inclined lines.
- They are also used for setting combination of angles of 15^o, while using T-square.
- Along with minidrafter set-squares, they are also used to draw inclined lines of 30^o, 45^o, and 60^o as shown in Figure 1.7c.
- Protractor of circular or semicircular type is used to set up or measure angles.
- Large size protractor should be used to obtain accurate setup and measurements.



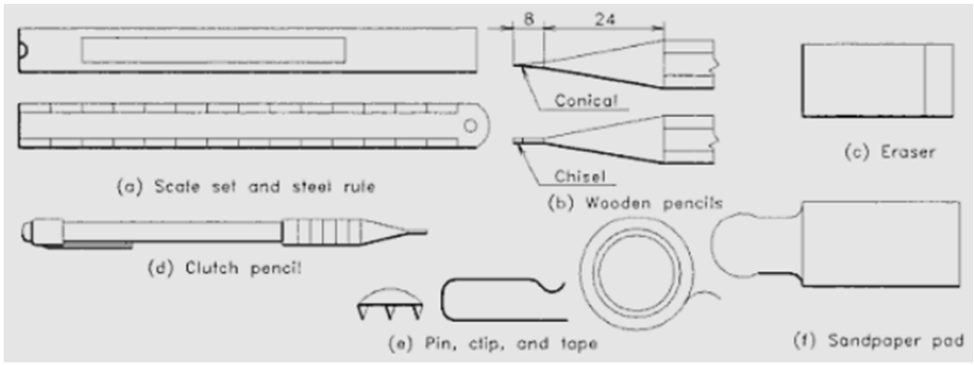
Engineers Scale Set and Steel Rule

- This is a set of 8 scales designated from M1 to M8 which are used to take measurements for scaled drawings (Figure 1.8a).
- They are made of either cardboard or plastic.
- A steel rule of 30 cm length is also recommended to draw inclined lines as well to use as full size scale for measurements.



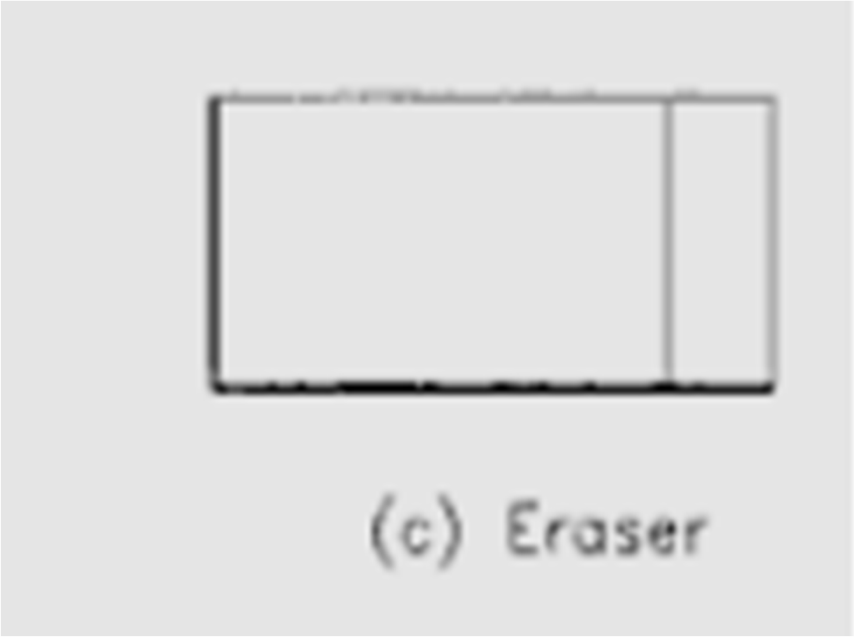
Drawing Pencils

- Two types of pencils (wooden drawing and clutch pencils) are used to prepare drawings
- Wooden drawing pencils of hexagonal cross section are the traditional types used for engineering graphics.
- They are designated as HB, H, 2H e.t.c.
- H stands for hardness and B for blackness and softness.
- They are sharpened as shown in Figure 1.8b to conical point or chisel point.
- Chisel pointed pencil is used for finishing thick lines.



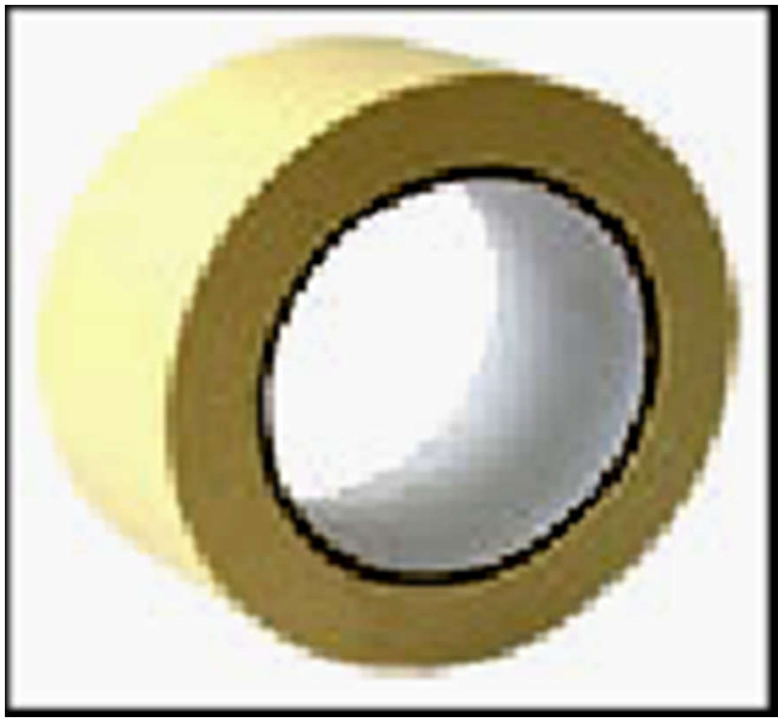
Eraser

- Soft natural rubber is used to remove unnecessary lines on the drawing sheet (Figure 1.8c).



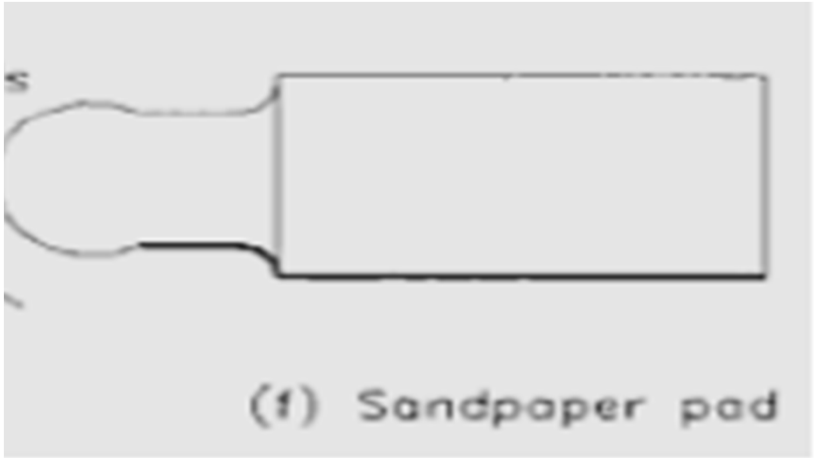
Adhesive Tape

- Adhesive tape is used to fix the drawing sheet on the drawing board (Figure 1.8e)



Sandpaper Pad

- It consists of a small wooden block on which fine grained sandpaper is pasted about half of its length (Figure 1.8f)
- It is used to sharpen wooden pencil lead and compass lead tip for correct line thickness



Blade, or Pencil Sharpener

- They are used for sharpening the wooden pencil and cutting of drawing sheets to the required size.

Handkerchief, Duster or Dusting Brush

- Cleaning of board, and drawing sheet is carried out using duster or dusting brush.
- Handkerchief can be used for this as well as wiping wet hands.

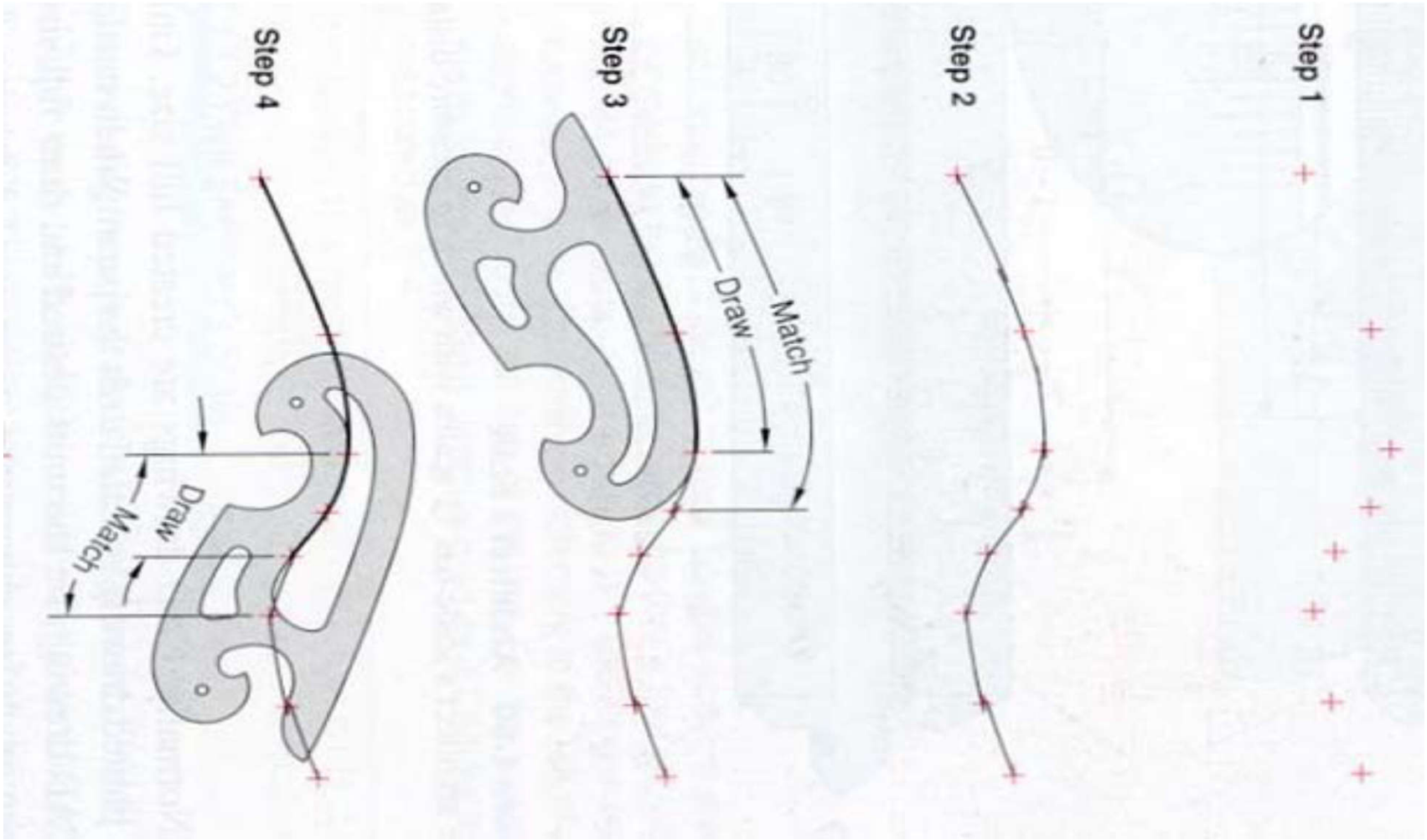
Letter Stencils, French Curves

- These items are used to improve the speed and finish of drawing (Figure 1.9)
- Letter stencils are used to print letters especially in tracing.
- French curves or irregular curves are used for drawing curved lines other than constant radius arcs.
- They are available in different forms and sizes in boxes.

(a) Letter stencil

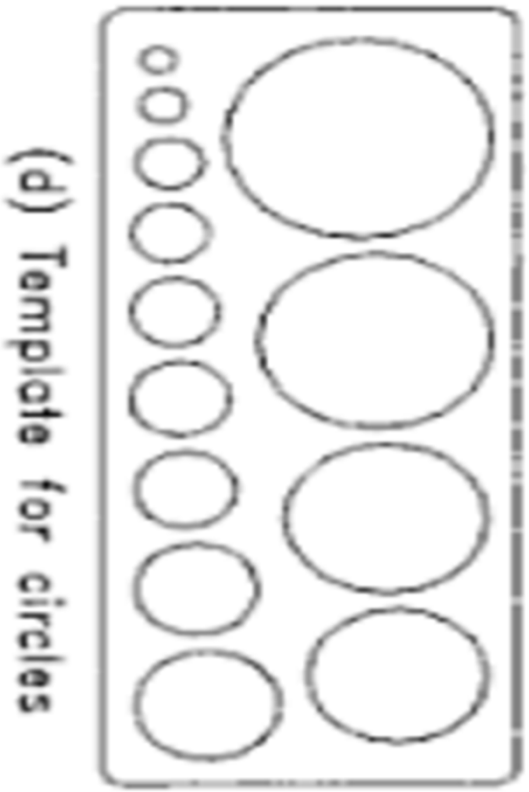
(b) French curve

French Curves



Templates

- Templates are plastic sheets with the standard shapes like circles, ellipses, symbols etc. cut in them so that the drawing can be made fast and accurate.
- Templates are widely used for tracing drawings.



(d) Template for circles

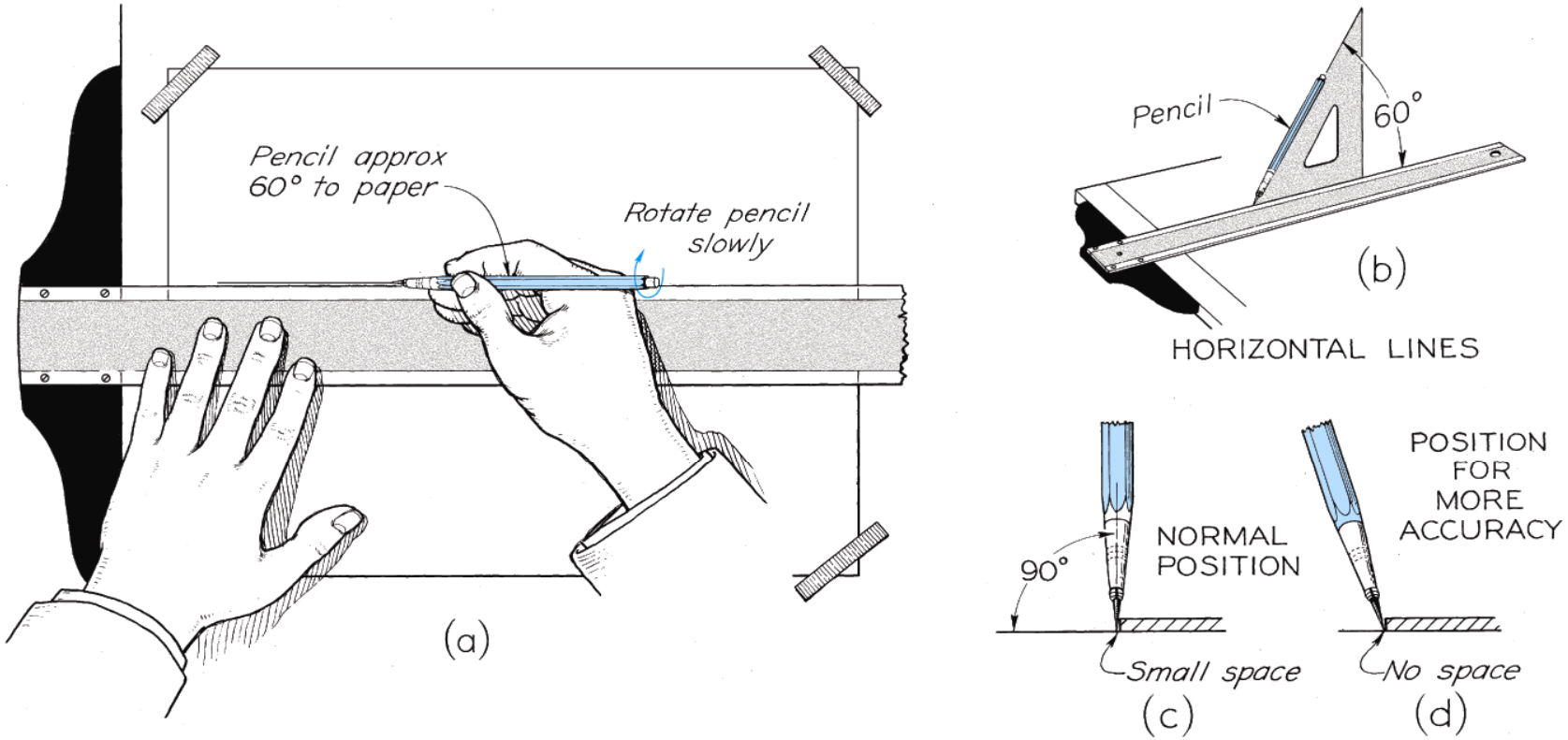


Figure 3-11

Drawing a Horizontal Line.

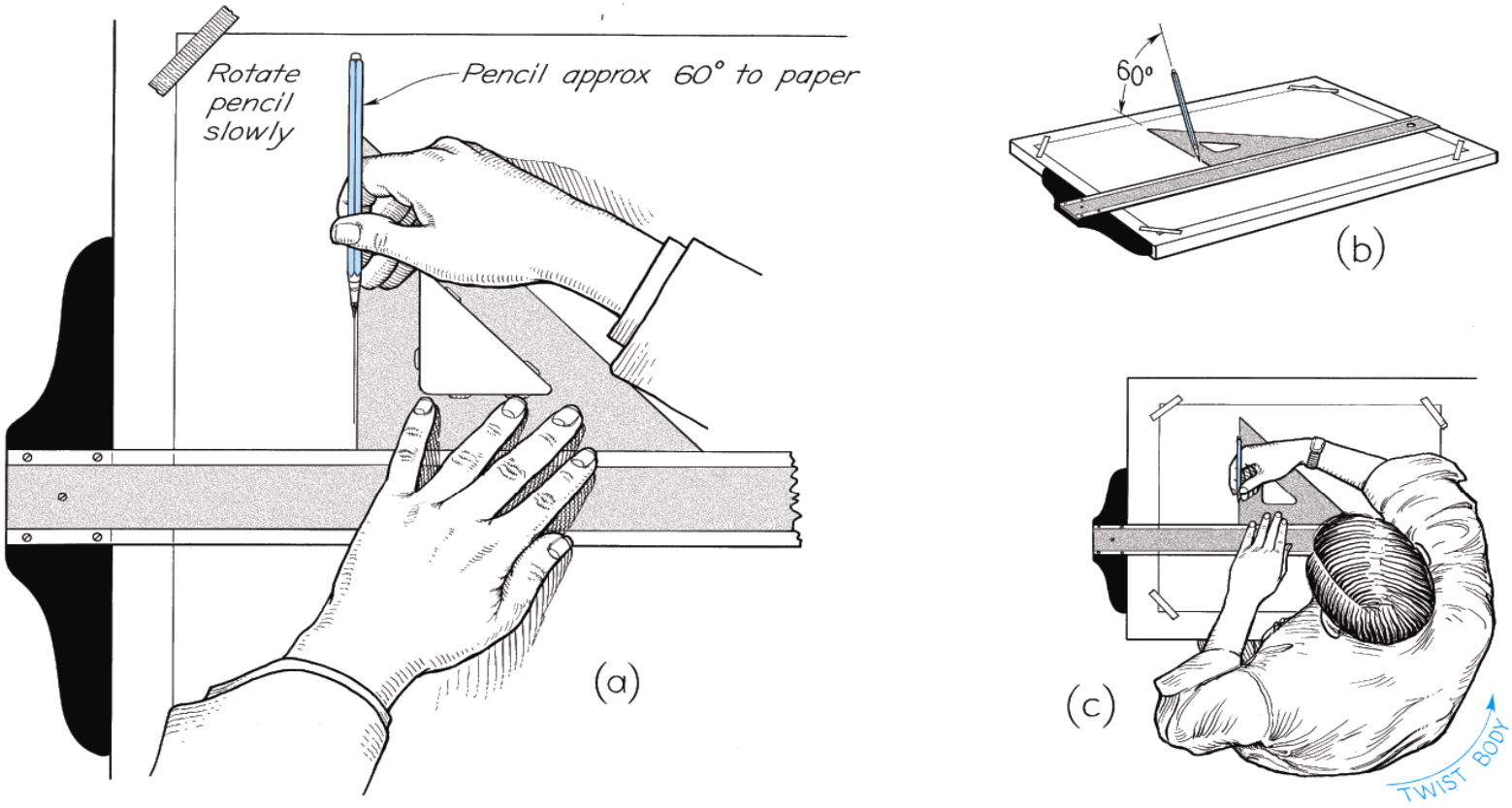


Figure 3-12

Drawing a Vertical Line.

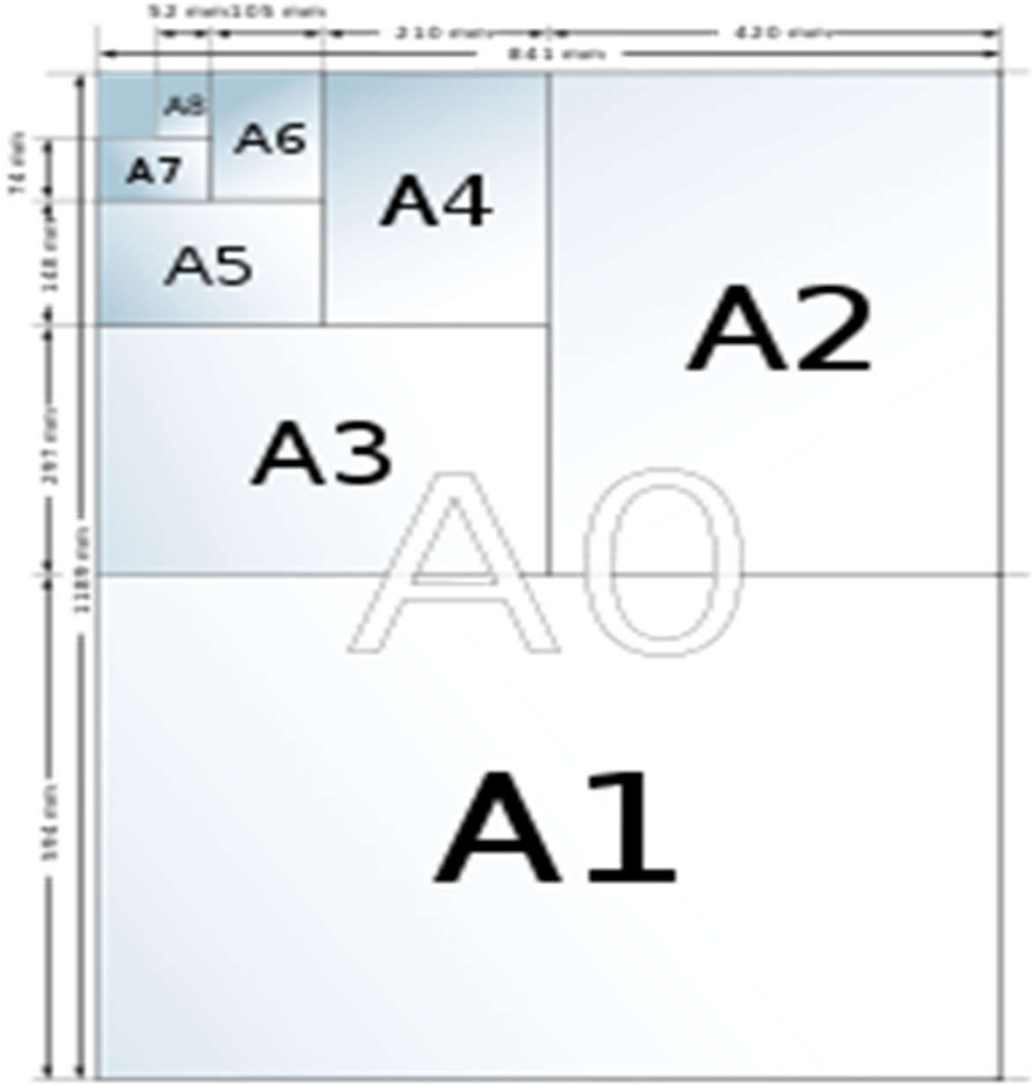
Drawing Pencils

- The conical and chisel points are shaped by grinding the cylindrical lead on the sandpaper pad.
- Mechanical clutch pencils of lead size 0.5 mm diameter are now available for drawings (Figure 1.8d).
- They are preferred because they can give better uniform line width and no sharpening is required.
- Lead grades of HB, H, and 2H are also used in mechanical clutch pencils.

Paper size

- Sizes of drawings typically comply with either of two different standards, ISO (World Standard) or ANSI/ASME Y14 (American), according to the following tables:

Paper size



Paper size

- ISO paper sizes
- **ISO A Drawing Sizes (mm)**
- **A4** 210 X 297
- **A3** 297 X 420
- **A2** 420 X 594
- **A1** 594 X 841
- **A0** 841 X 1189

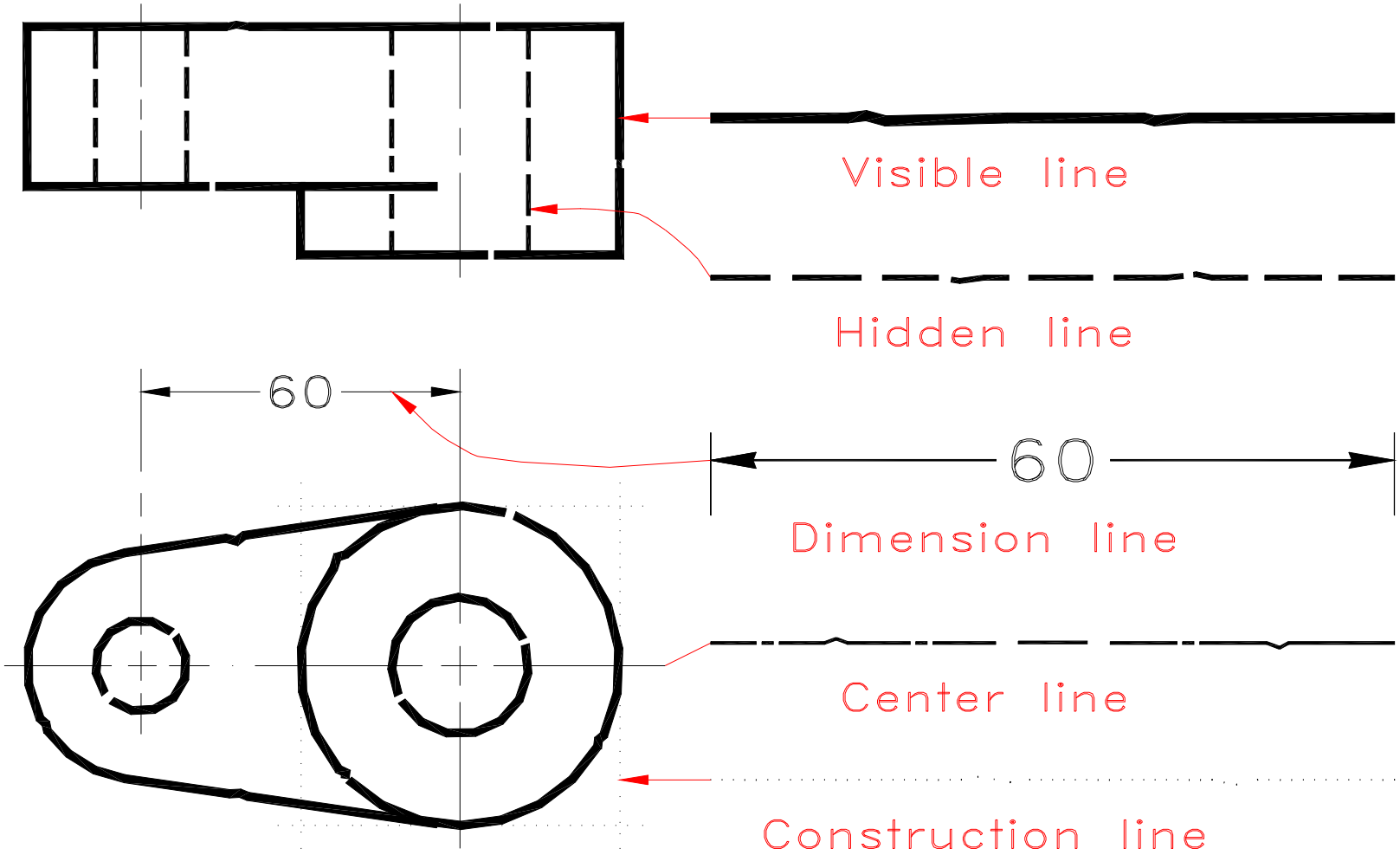
Lines

- Line work is very important in engineering graphics because various types of line has a specific meaning and function.
- Different types of lines are presented in Table 1.1.
- Table 1.1 explains how lines of various thickness are used either in electrical or pipe work diagrams.
- Figure 1.10 shows the use of various types of lines in engineering graphics.

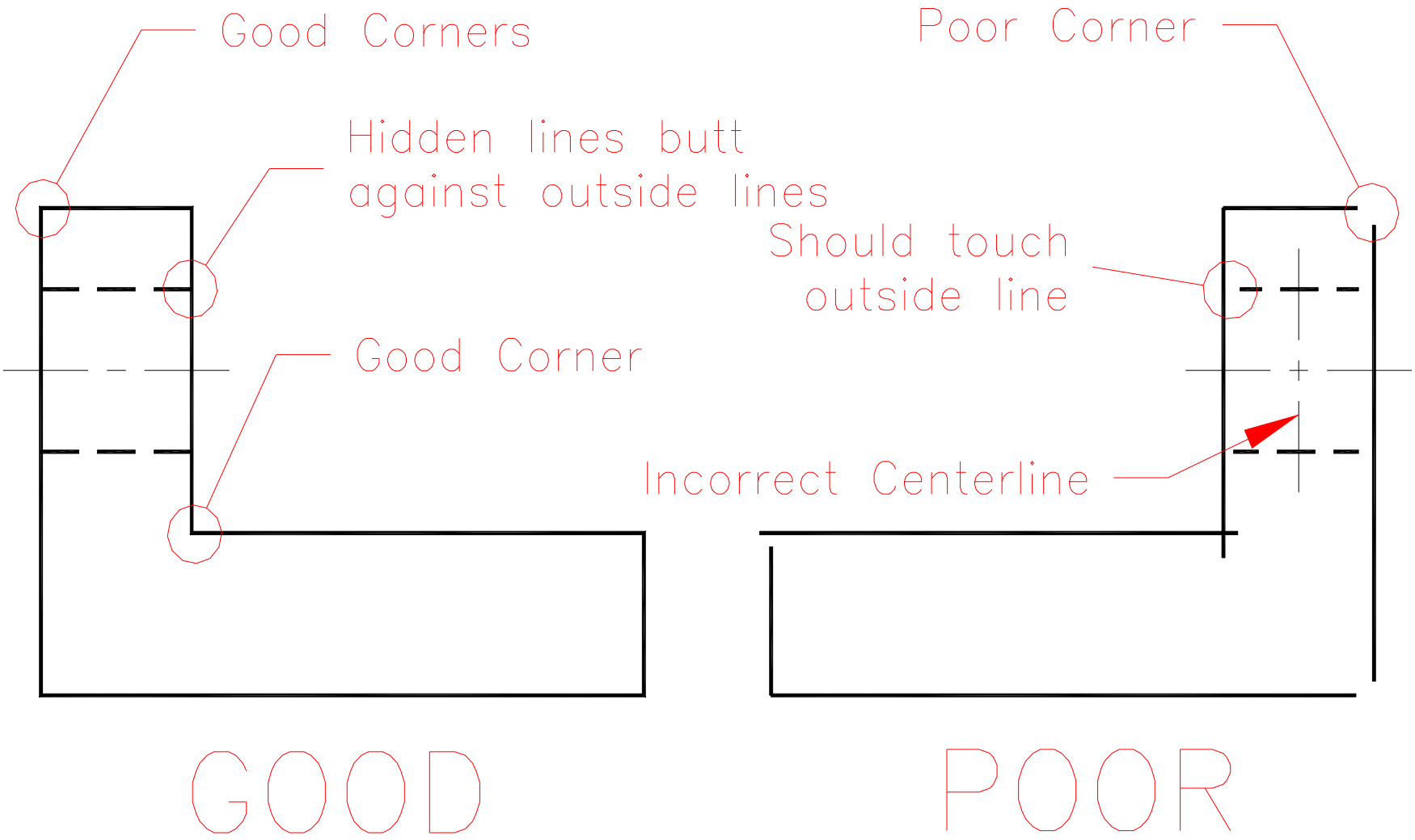
Lines

Line	Description
A	Continuous thick
B	Continuous thin
C 	Continuous thin freehand
D 	Continuous thin with zig-zags
E 	Dashed thick
F	Dashed thin
G	Chain thin
H 	Chain thin, thick at ends and changes of direction
J	Chain thick
K	Chain thin double dashed

Lines


Visible line
Hidden line
60
60
Dimension line
Center line
Construction line

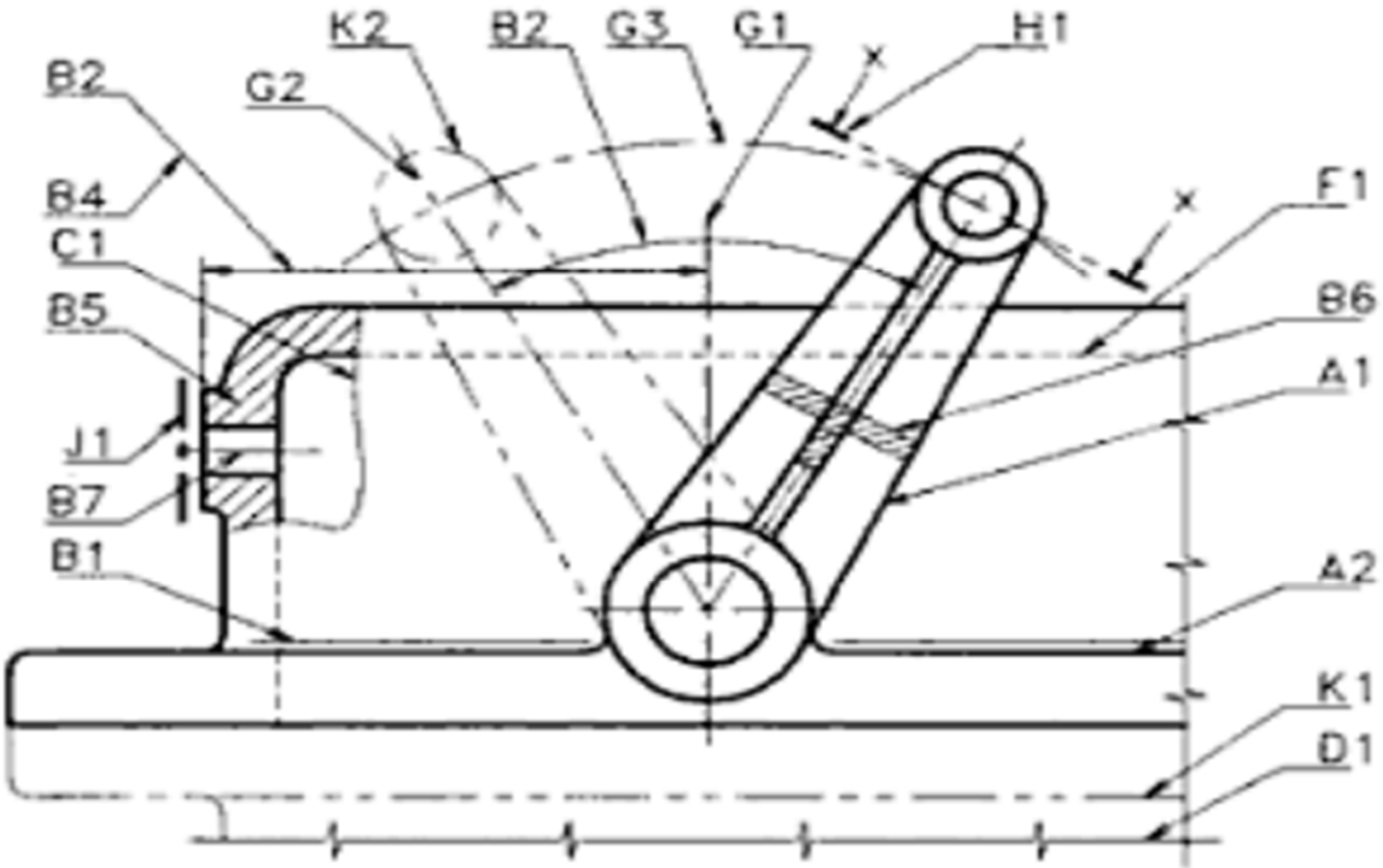
Lines


Good Corners
Hidden lines butt
against outside lines
Good Corner
Poor Corner
Should touch
outside line
Incorrect Centerline
GOOD
POOR

Types of Lines

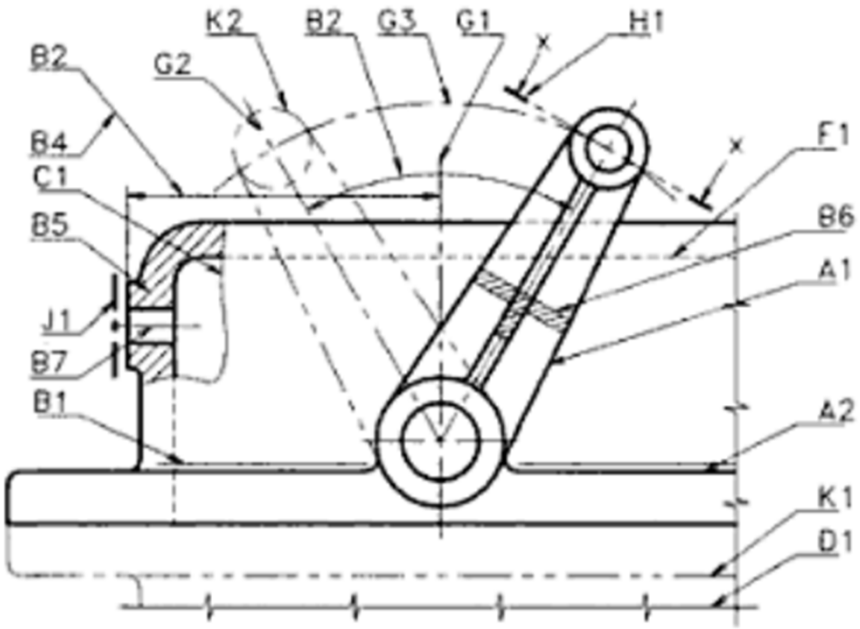
- Type A: It is a continuous thick line used to represent:
  - A1 Visible outlines
  - A2 Visible edges
- Type A lines are also used for the following applications (thread ends, limits of useful thread lengths, and main representation in diagrams, graphs, charts, and flow diagrams.

Types of Lines



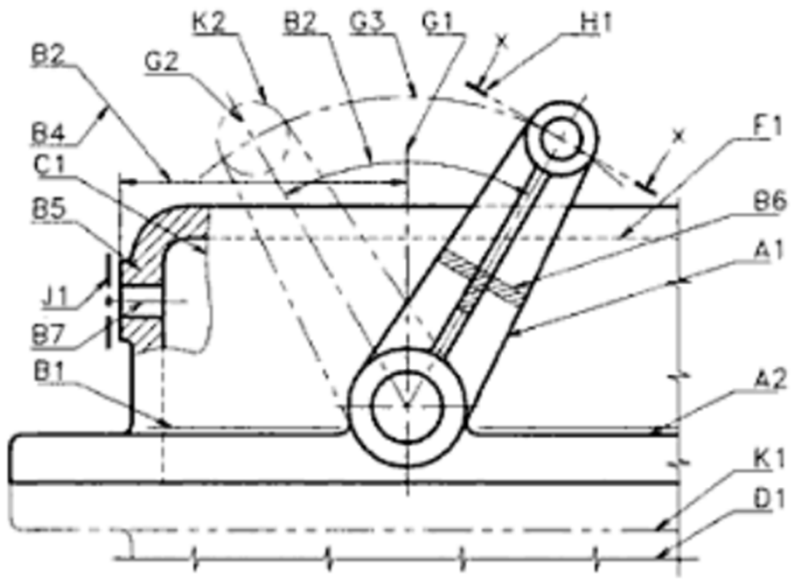
Types of Lines

- Type B lines:
  - These are continuous thin lines used for the representation of:
    - B1 Imaginary lines of intersection
    - B2 Dimension lines
    - B3 Projection lines
    - B4 Leader lines
    - B5 Hatching (section) lines
    - B6 Outline of revolved section in place
    - B7 Short centre lines



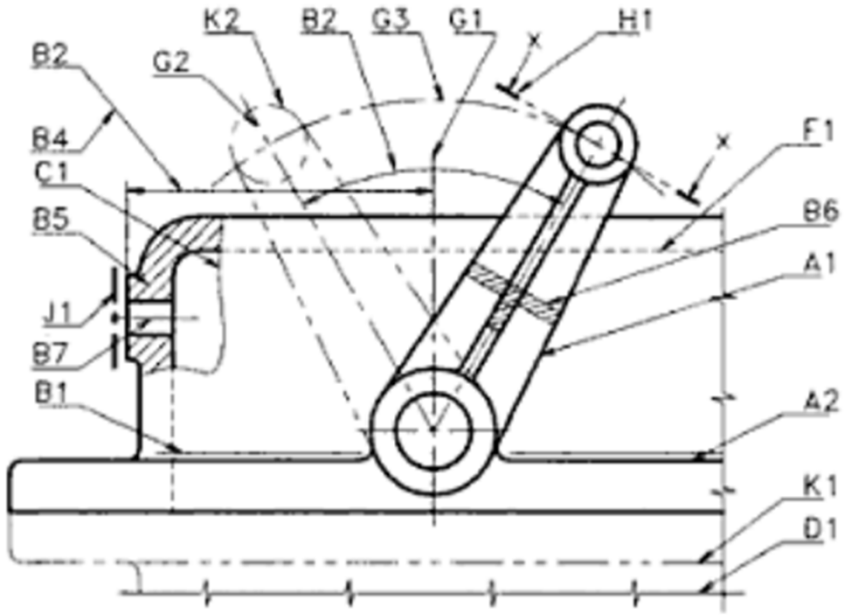
Types of Lines

- Type C lines are continuous thin lines drawn freehand to represent:
  - C1 Limits of partial views, interrupted views, and sectional views, and sectional views (if limits are not chain thin lines)



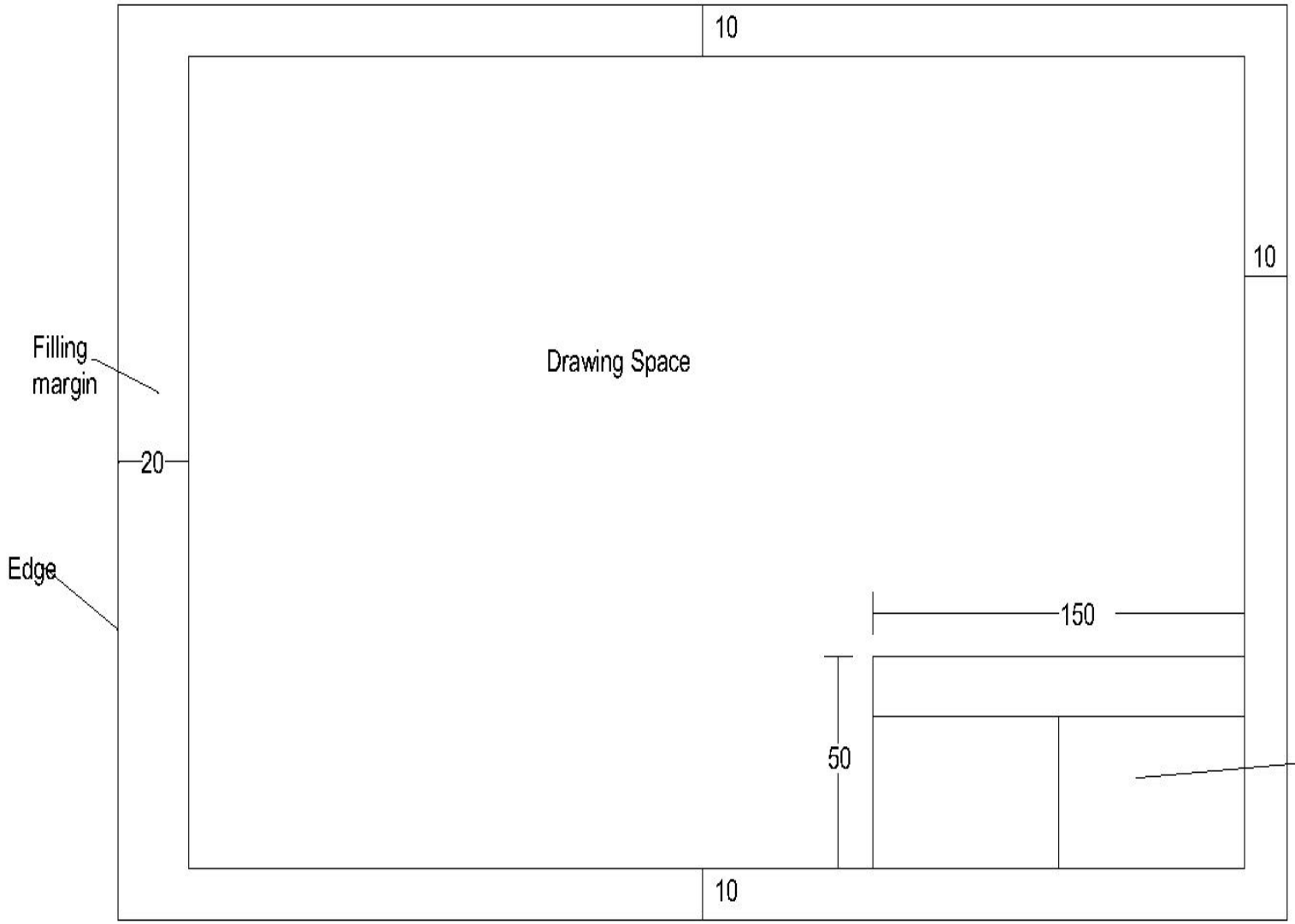
Types of Lines

- Type D lines are continuous thin (straight or curved) lines with zig-zags and are used for
  - D1 Limit of partial views, interrupted views, and sectional views (if limits are chain thin lines)

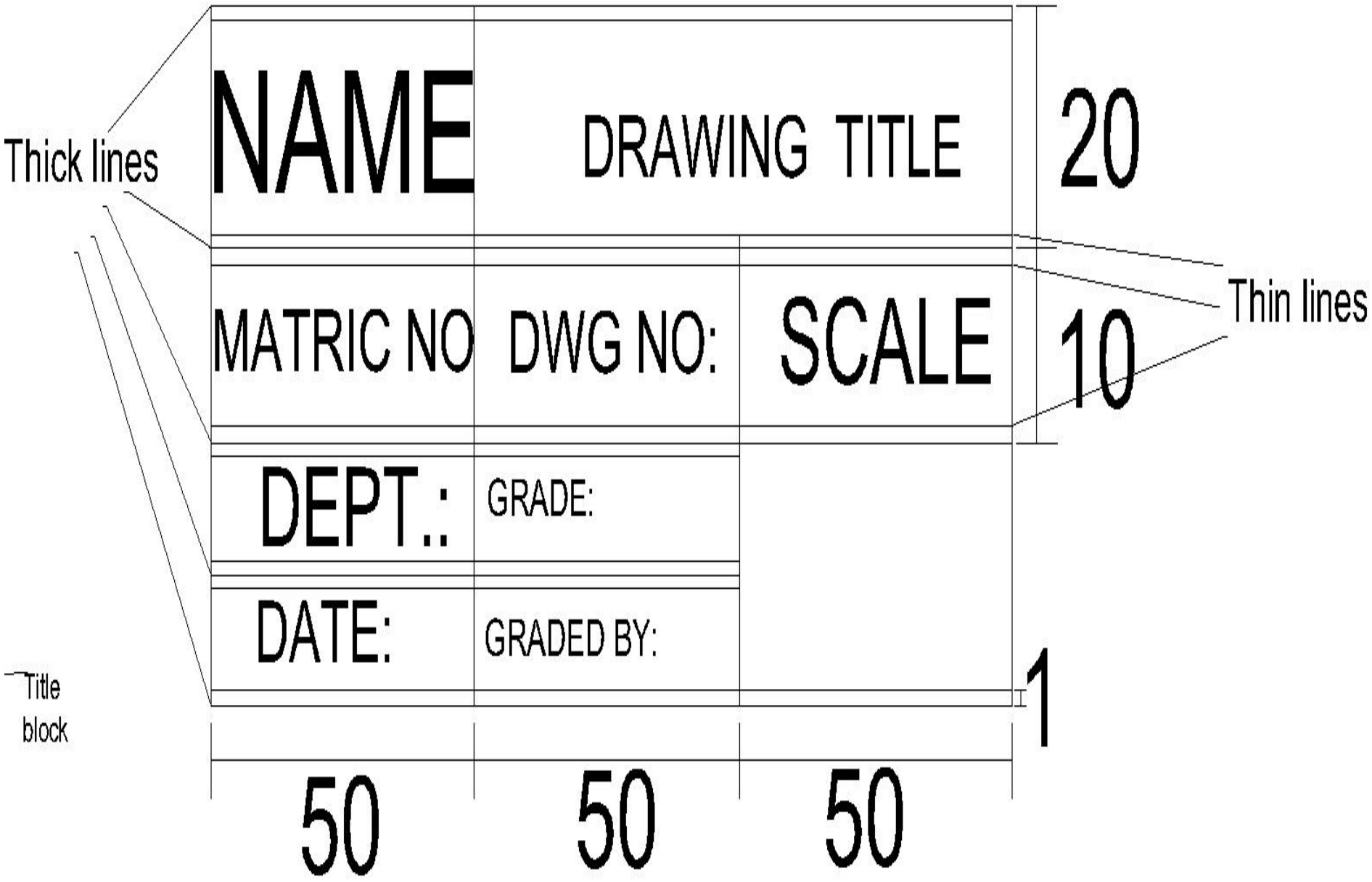


Types of Lines

Line	*Description*	*General applications*
A ————	Continuous thick	A1 Visible outlines A2 Visible edges
B ————	Continuous thin (straight or curved)	B1 Imaginary lines of intersection B2 Dimension lines B3 Projection lines B4 Leader lines B5 Hatching B6 Outlines of revolved section in place B7 Short centre lines
C ~~~~~~~~	Continuous thin freehand**	C1 Limits of partial or interrupted views and sections, if the limit is not a chain thin line
D* —/—/—/—	Continuous thin (straight) with zigzags	D1 -------do-------
E — — — — —	Dashed thick**	E1 Hidden outlines E2 Hidden edges
F - - - - - -	Dashed thin	F1 Hidden outlines F2 Hidden edges
G ——·——·——	Chain thin	G1 Centre lines G2 Line of symmetry G3 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 requirement applies



Layout of sheet for class work

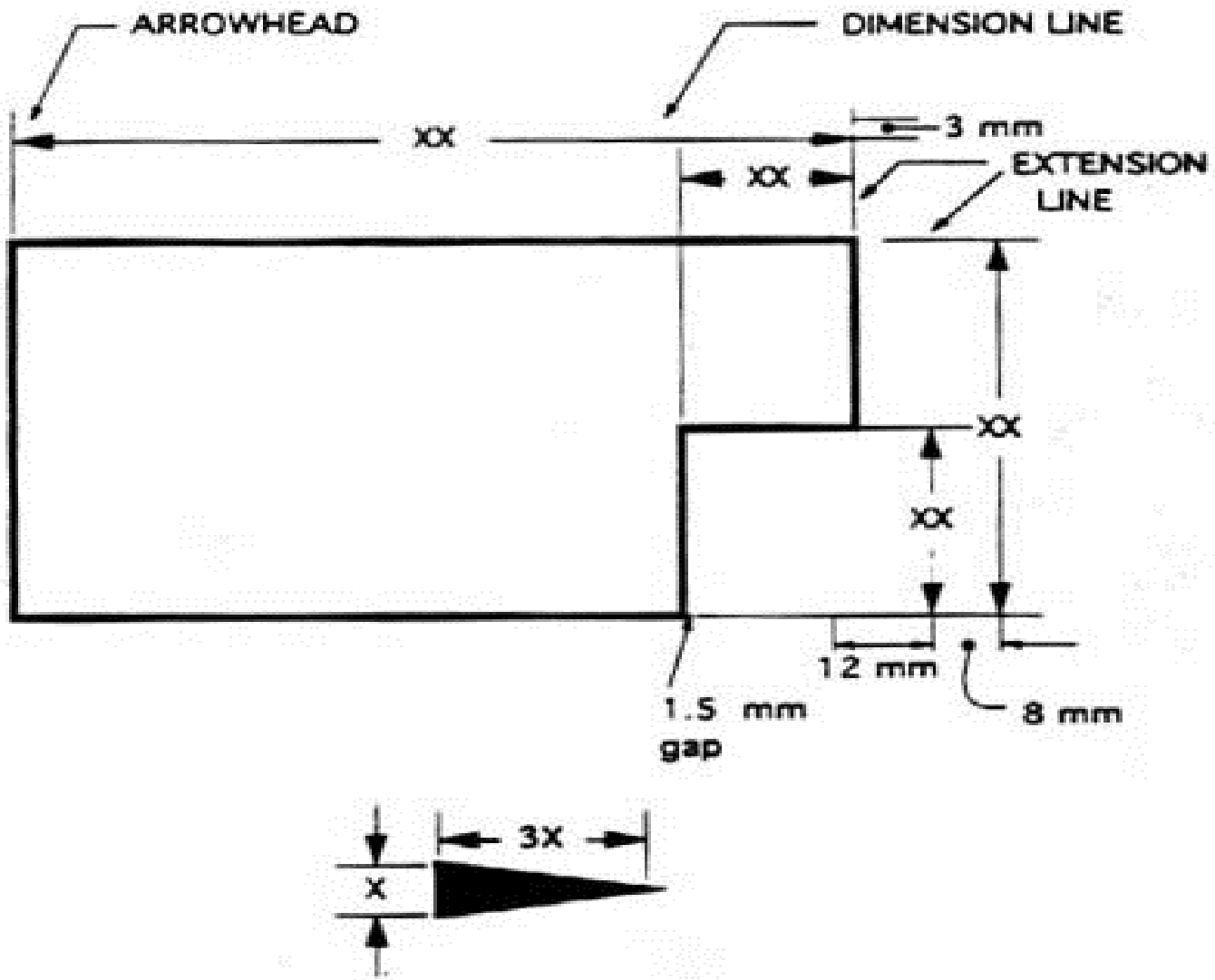


Layout of the title block

Dimensioning

- The **dimension line** is a thin line, broken in the middle to allow the placement of the dimension value, with arrowheads at each end (figure 2:1).

Dimensioning (Contd)



Dimensioning (Contd)

- An **arrowhead** is approximately 3 mm long and 1 mm wide. That is, the length is roughly three times the width. An **extension line** extends a line on the object to the dimension line. The first dimension line should be approximately 12 mm (0.6 in) from the object. Extension lines begin 1.5 mm from the object and extend 3 mm from the last dimension line.

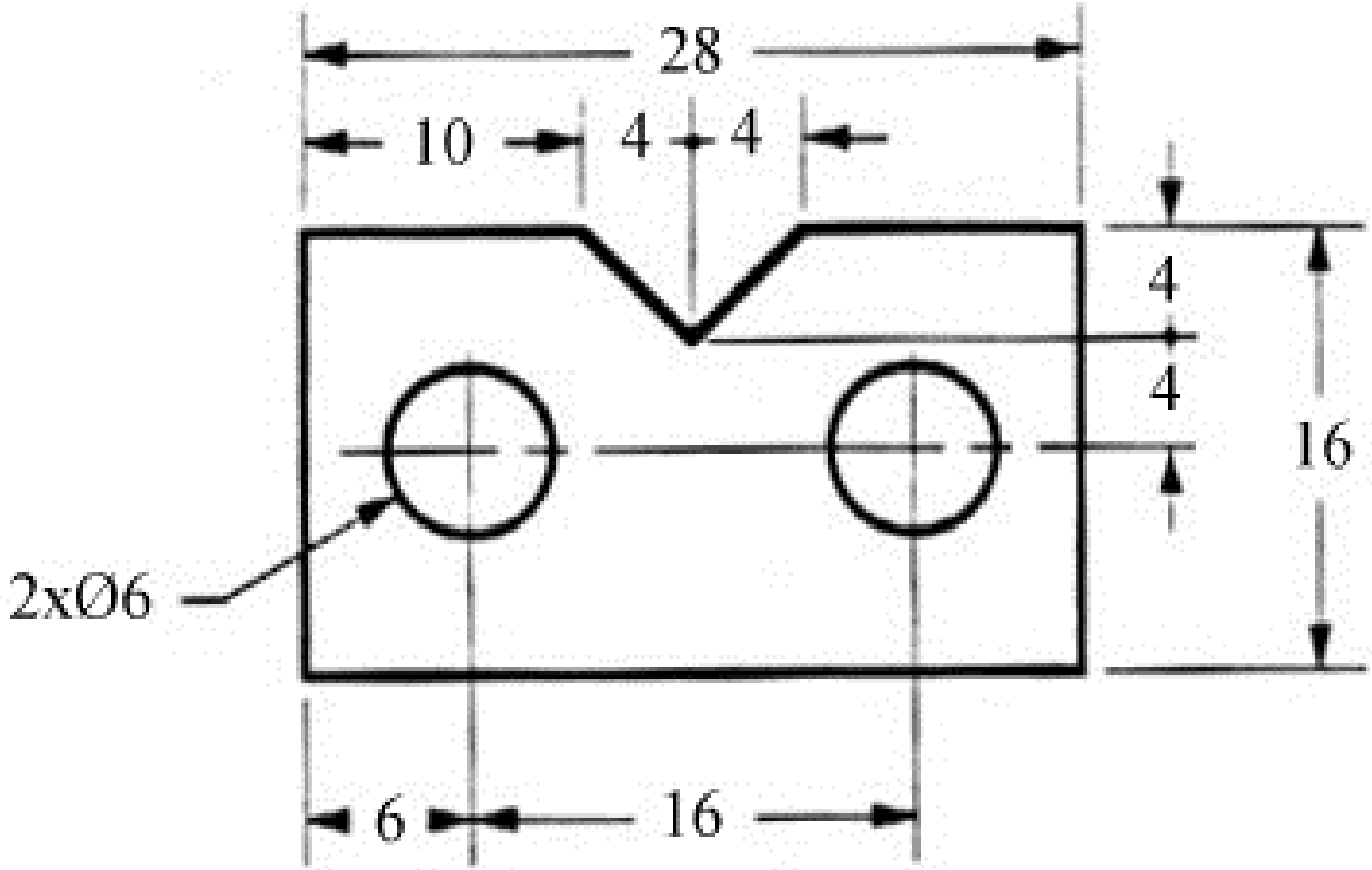
Dimensioning (Contd.)

- The purpose of dimensioning is to provide a clear and complete description of an object. A complete set of dimensions will permit only one interpretation needed to construct the part. Dimensioning should follow these guidelines.
- Accuracy: correct values must be given.
- Clearness: dimensions must be placed in appropriate positions.
- Completeness: nothing must be left out, and nothing duplicated.
- Readability: the appropriate line quality must be used for legibility.

Dimensioning (Contd.)

- A leader is a thin line used to connect a dimension with a particular area (figure 2.2)
- A leader may also be used to indicate a note or comment about a specific area. When there is limited space, a heavy black dot may be substituted for the arrows, as in figure 2.1. Also in this drawing, two holes are identical, allowing the "2x" notation to be used and the dimension to point to only one of the circles.

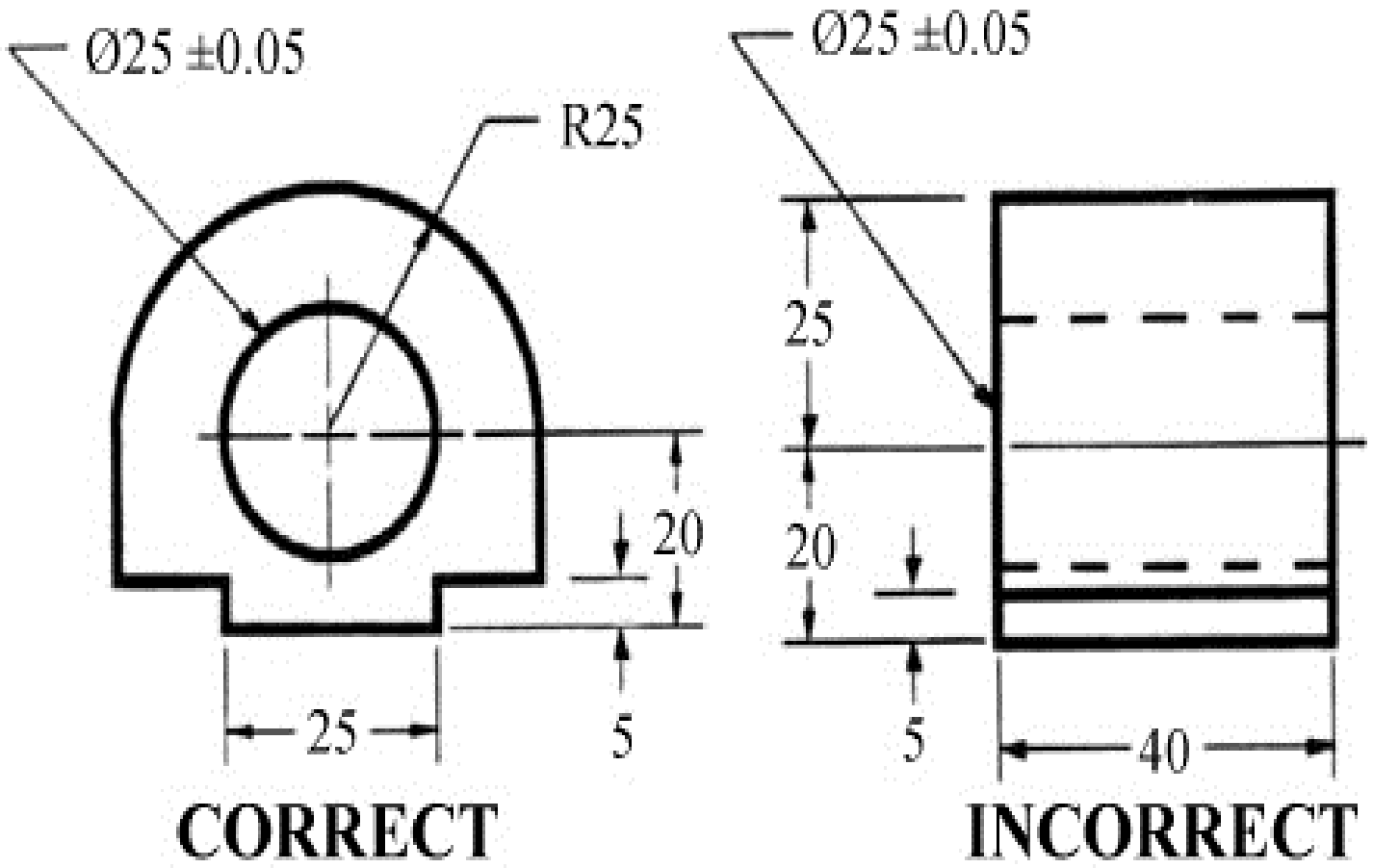
Dimensioning (Contd.)



Dimensioning (Contd.)

- **Where to Put Dimensions**
- The dimensions should be placed on the face that describes the feature most clearly. Examples of appropriate and inappropriate placing of dimensions are shown in figure 2.3.

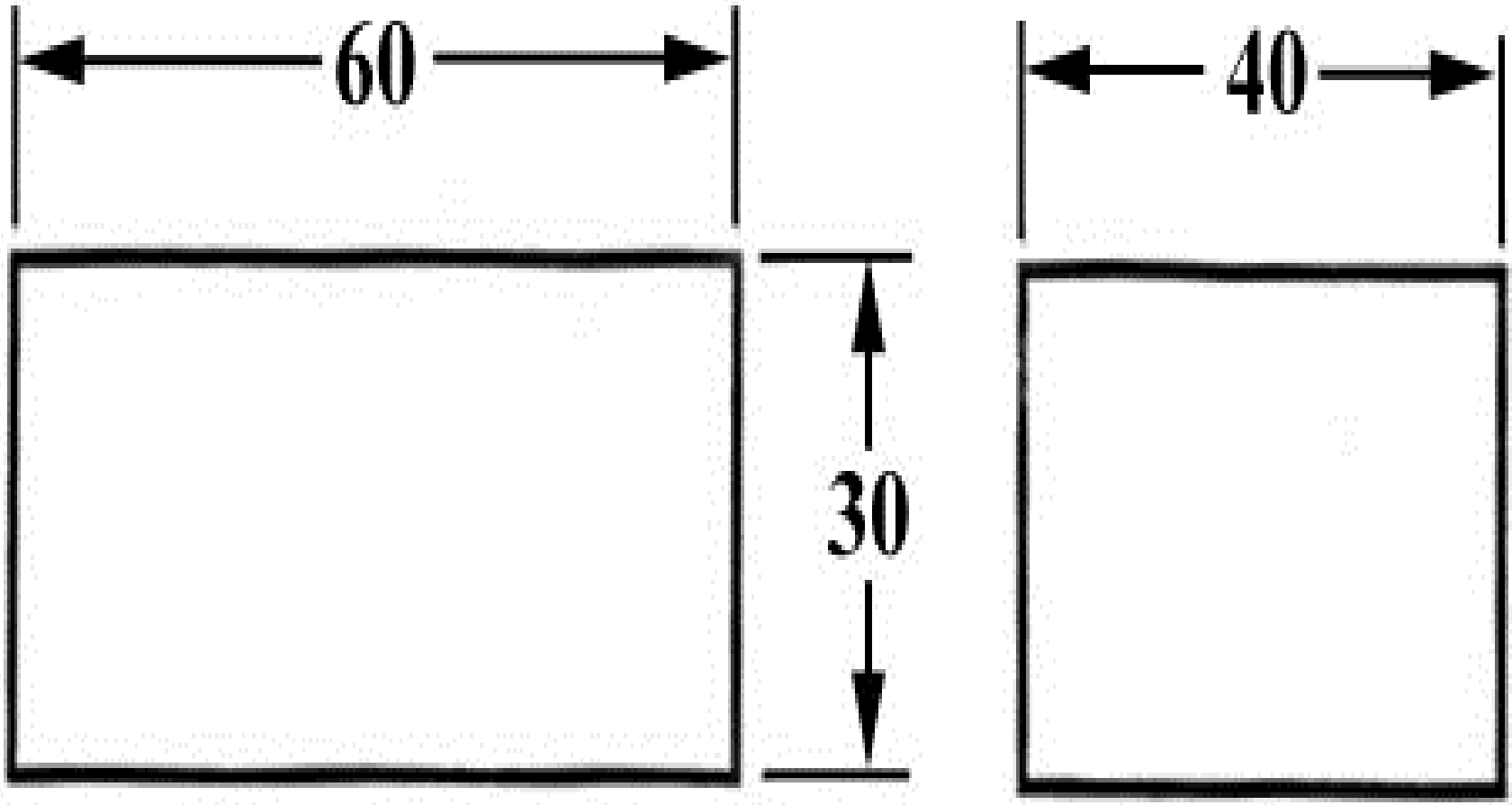
Dimensioning (Contd.)



Dimensioning (Contd)

- In order to get the feel of what dimensioning is all about, we can start with a simple rectangular block. With this simple object, only three dimensions are needed to describe it completely (figure 2.4). There is little choice on where to put its dimensions.

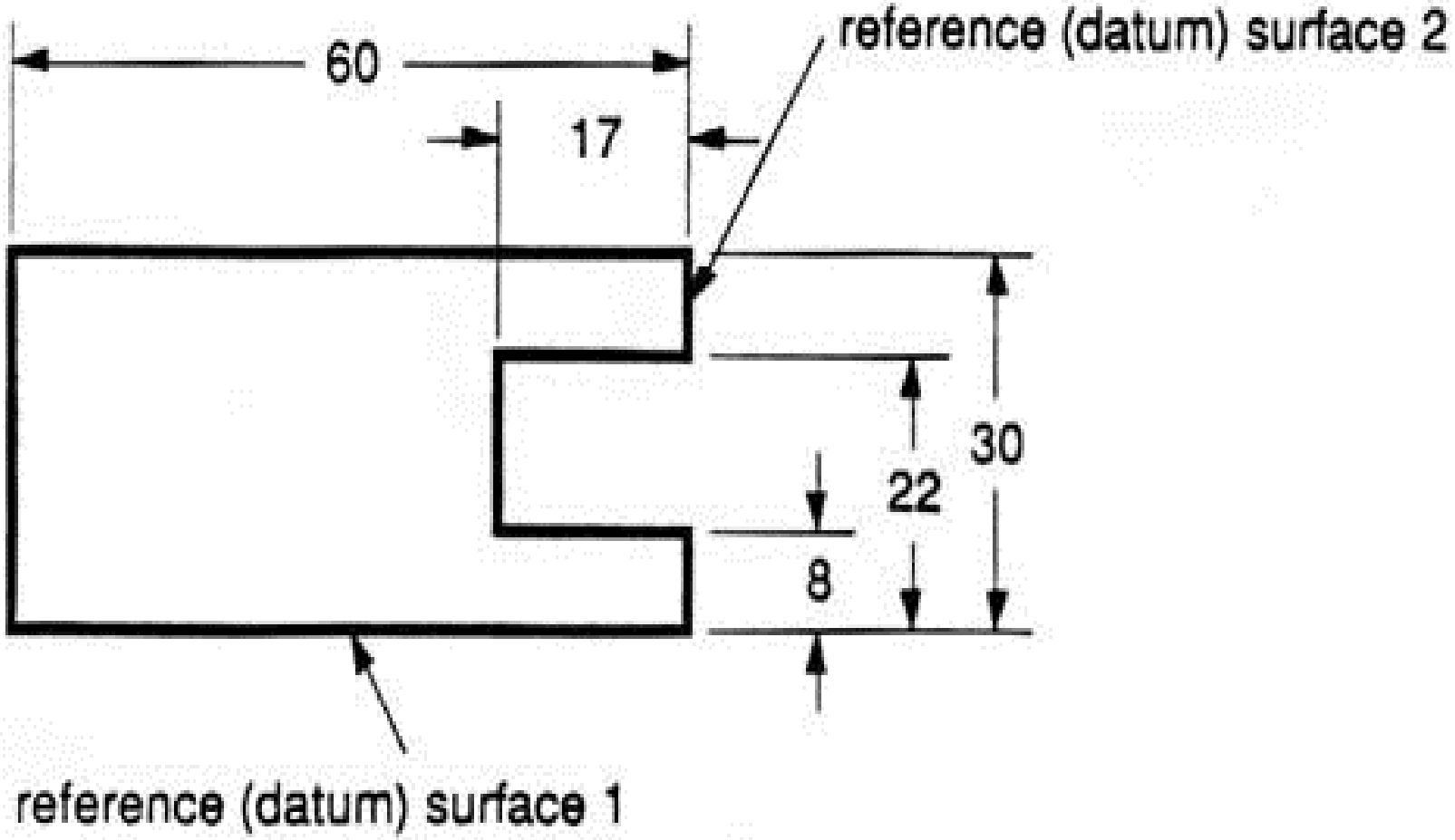
Dimensioning (Contd.)



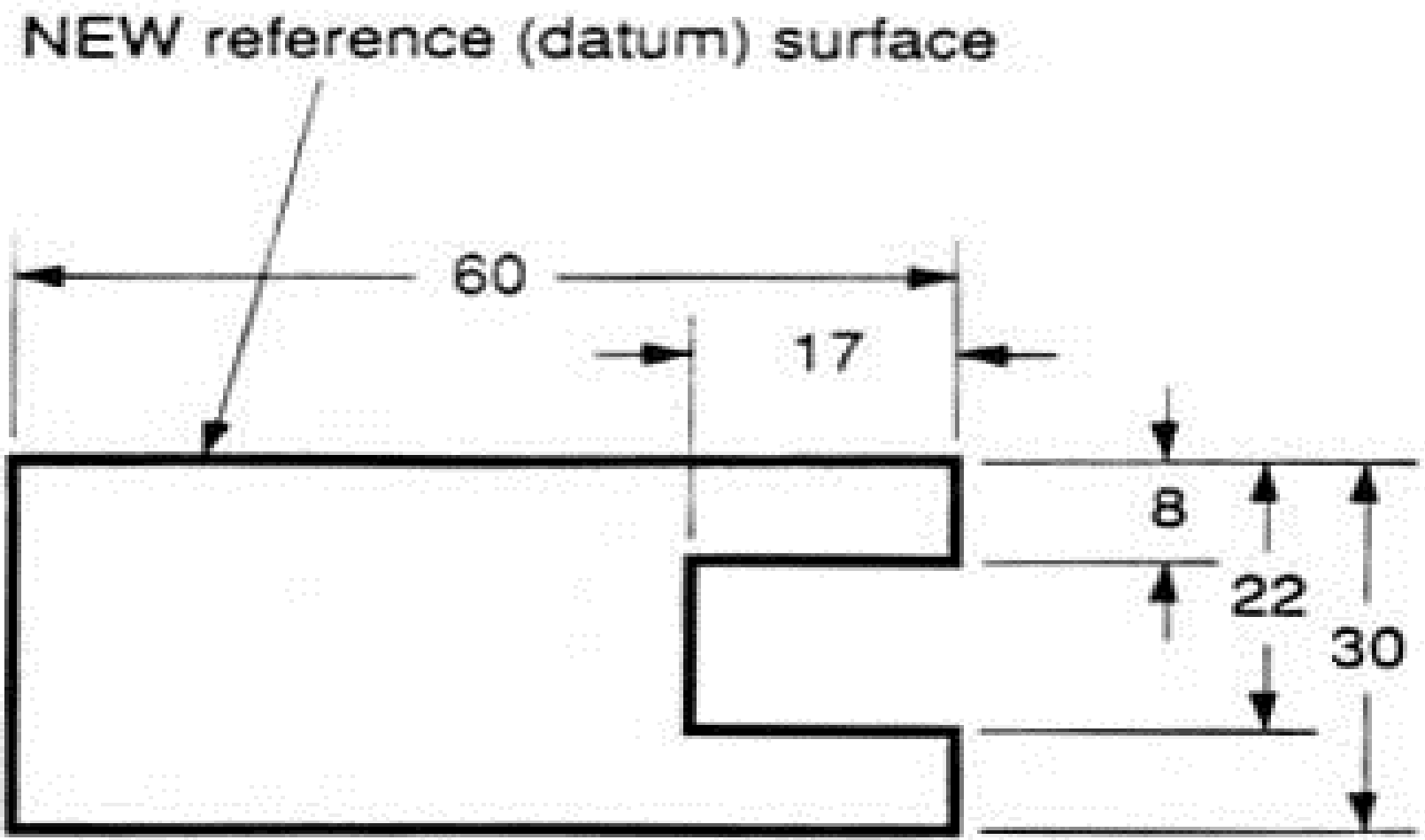
Dimensioning (Contd.)

- We have to make some choices when we dimension a block with a notch or cutout (figure 2.5). It is usually best to dimension from a common line or surface. This can be called the datum line of surface. This eliminates the addition of measurement or machining inaccuracies that would come from "chain" or "series" dimensioning. Notice how the dimensions originate on the datum surfaces. We chose one datum surface in figure 2.5, and another in figure 2.6. As long as we are consistent, it makes no difference. (We are just showing the top view).

Dimensioning (Contd.)



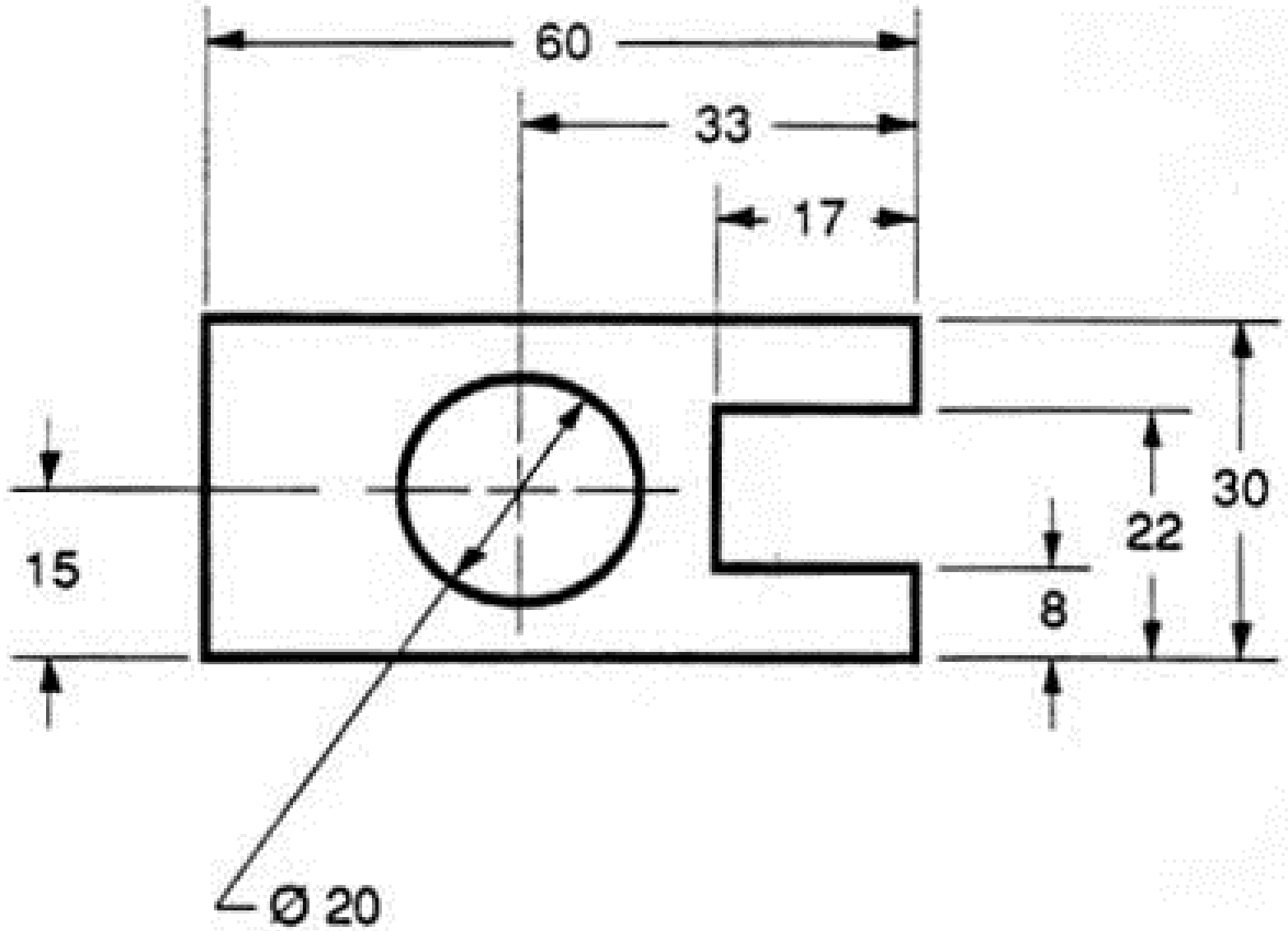
Dimensioning (Contd.)



Dimensioning (Contd.)

- In figure 2.7, we have shown a hole that we have chosen to dimension on the left side of the object. The Ø stands for "diameter".

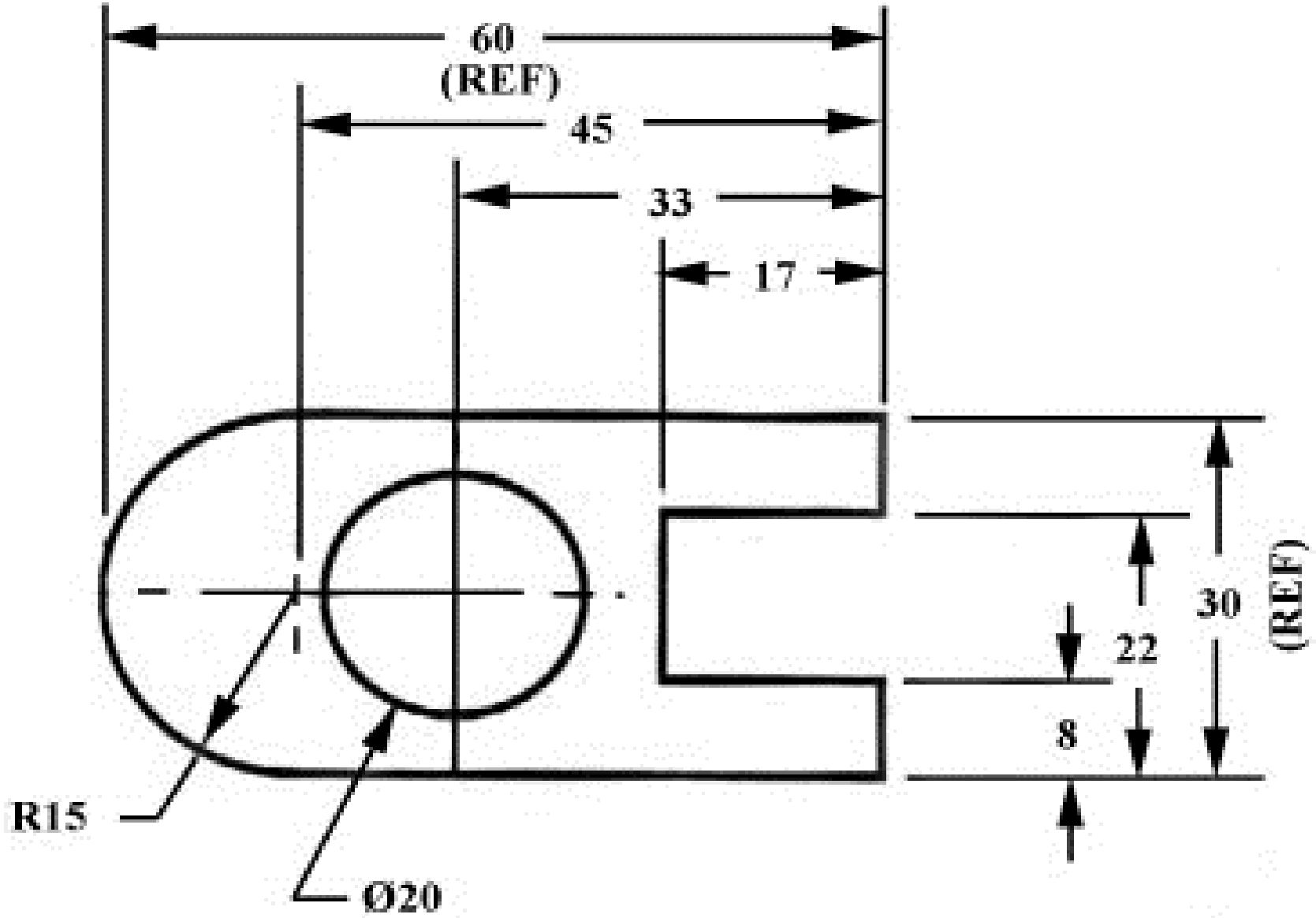
Dimensioning (Contd.)



Dimensioning (Contd.)

- When the left side of the block is "radiuses" as in figure 3.8, we break our rule that we should not duplicate dimensions. The total length is known because the radius of the curve on the left side is given. Then, for clarity, we add the overall length of 60 and we note that it is a reference (REF) dimension. This means that it is not really required.

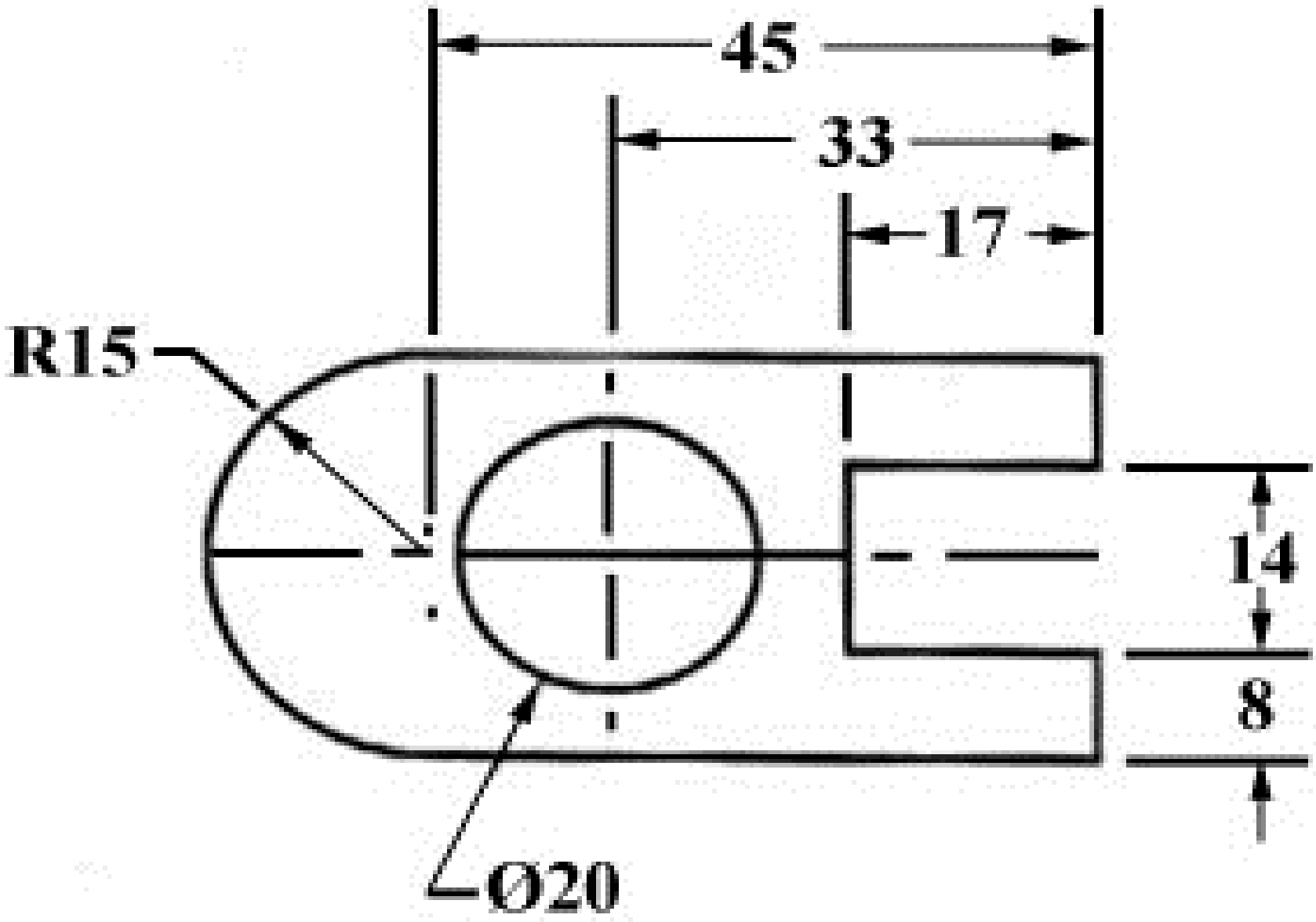
Dimensioning (Contd.)



Dimensioning (Contd.)

- Somewhere on the paper, usually the bottom, there should be placed information on what measuring system is being used (e.g. inches and millimeters) and also the scale of the drawing.

Dimensioning (Contd.)



Dimensioning (Contd.)

- This drawing is symmetric about the horizontal centerline. Centerlines (chain-dotted) are used for symmetric objects, and also for the center of circles and holes. We can dimension directly to the centerline, as in figure 3.9. In some cases this method can be clearer than just dimensioning between surfaces.