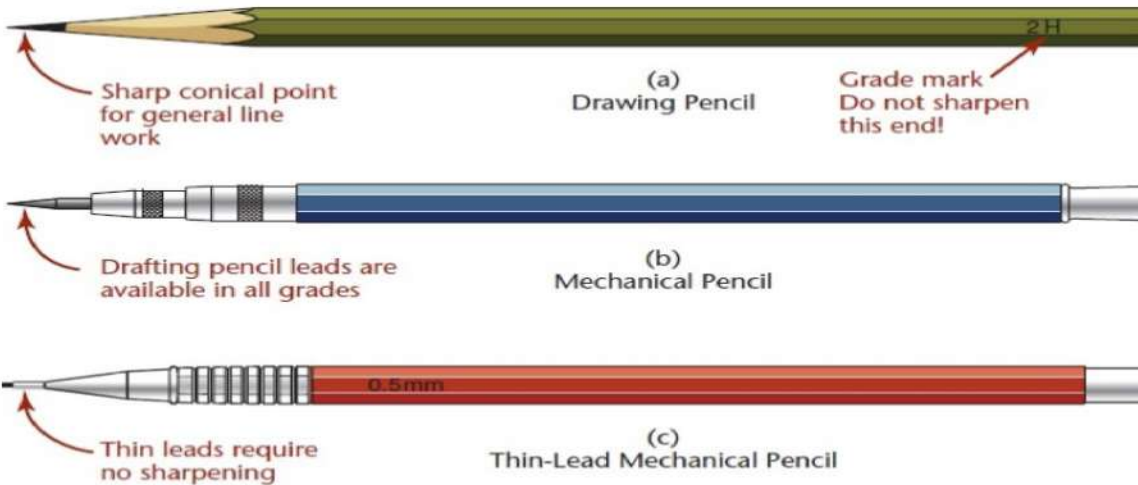
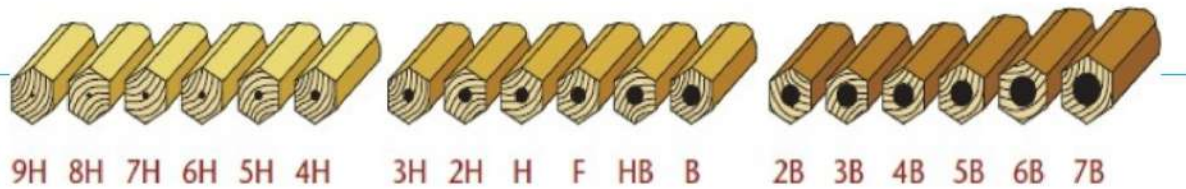


Engineering Drawing Principles L-3



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Pencils



Every line of the drawing should indicate its importance. It depends upon the hardness of pencil. Based on the hardness quality pencils are classified into 18 grades

Grade of Pencil	Used to Draw
3H	Construction lines
2H	Dimension lines, center lines, sectional lines, hidden lines
H	Object lines, lettering
HB	Dimensioning, boundary lines

Pencils

Grade of Pencil	Hardness of Pencil
9H	Hardest
6H, 5H, 4H	Extremely Hard
3H	Very hard
2H	Hard
H	Moderately hard
F	Firm
HB	Medium hard
B	Moderately soft and black
2B	Soft and black
3B	Very soft and black
4B, 5B, 6B	Very soft and very black
7B	Softest









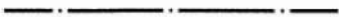

Grade of Pencil	Used to Draw
3H	Construction lines
2H	Dimension lines, center lines, sectional lines, hidden lines
H	Object lines, lettering
HB	Dimensioning, boundary lines

LINES

Various types of lines used in general engineering drawing are shown in table

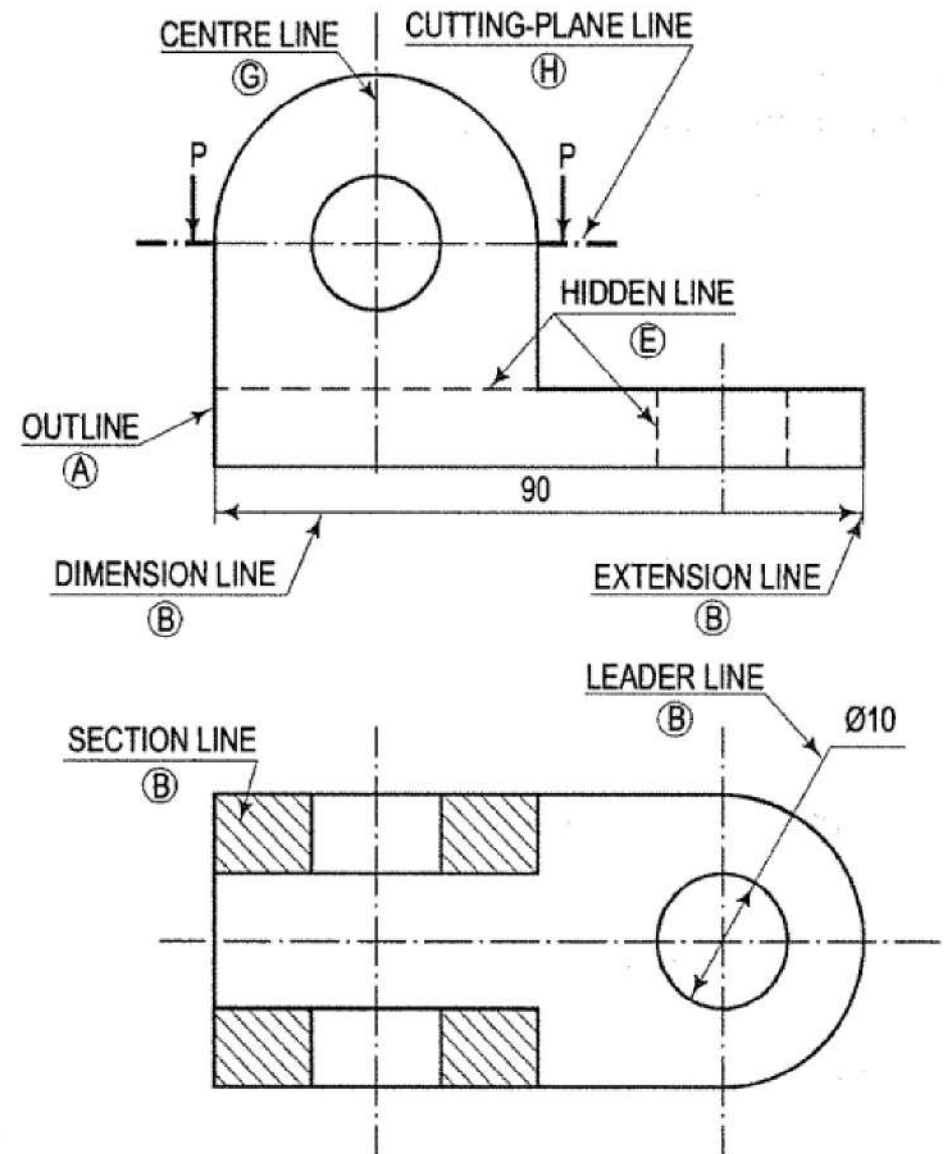
- Line thickness: The thicknesses of lines are varied according to the drawing and are finalized either by ink or by pencil.

- Inked drawings: The thicknesses of lines in various groups. The line-group is designated according to the thickness of the thickest line. For any particular drawing a line-group is selected according to its size and type.

Line	Description	General applications
A 	Continuous thick or Continuous wide	Visible outlines, visible edges; crests of screw threads; limits of length of full depth thread, lines of cuts and section arrows; parting lines of moulds in views; main representations in diagrams, maps, flow charts; system lines (structural metal engg.)
B 	Continuous thin (narrow) (straight or curved)	Imaginary lines of intersection; grid, dimension, extension, projection, short centre, leader, reference lines; hatching; outlines of revolved sections; root of screw threads; interpretation lines of tapered features; framing of details; indication of repetitive details;
C 	Continuous thin (narrow) freehand	Limits of partial or interrupted views and sections, if the limit is not a chain thin line
D 	Continuous thin (narrow) with zigzags (straight)	Long-break line
E 	Dashed thick (wide)	Line showing permissible of surface treatment
F 	Dashed thin (narrow)	Hidden outlines; hidden edges
G 	Chain thin Long-dashed dotted (narrow)	Centre line; lines of symmetry; trajectories; pitch circle of gears, pitch circle of holes,
H  THICK THIN THICK	Chain thin (narrow) with thick (wide) at the ends and at changing of position	Cutting planes
J 	Chain thick or Long-dashed dotted (wide)	Indication of lines or surfaces to which a special requirement applies
K 	Chain thin double-dashed or long-dashed double-dotted (narrow)	Outlines of adjacent parts Alternative and extreme positions of movable parts Centroidal lines Initial outlines prior to forming Parts situated in front of the cutting plane

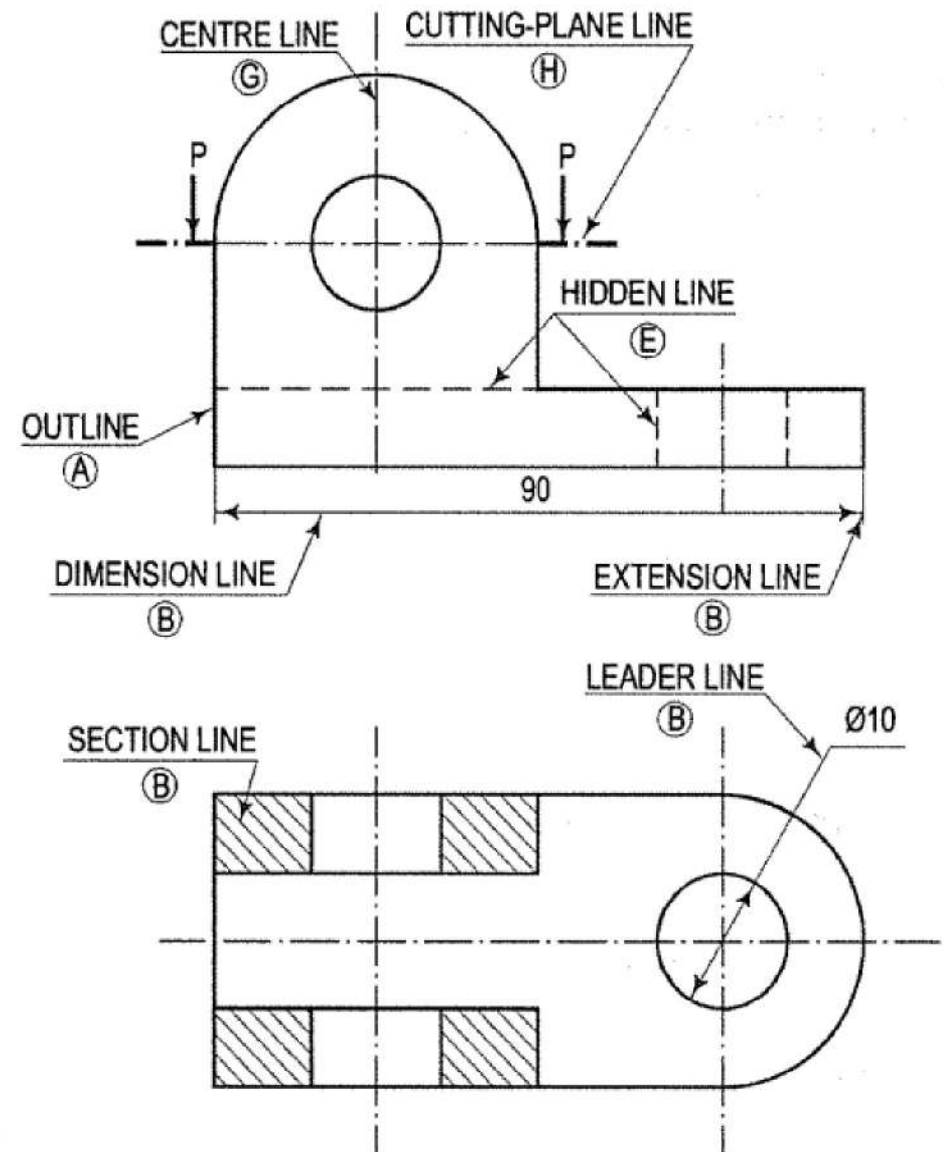
Type of Lines

- **Outlines:** Lines drawn to represent visible edges and surface boundaries of objects are called outlines or principal lines. They are continuous thick or wide lines
- **Extension or projection lines:** These lines also are continuous thin lines. They extend by about 3 mm beyond the dimension lines
- **Dimension Line:** These lines are continuous thin lines. They are terminated at the outer ends by pointed arrowheads touching the outlines, extension lines or centre lines
- **Hatching or section line:** These lines are drawn to make the section evident. They are continuous thin lines and are drawn generally at an angle of 45° to the main outline of the section. They are uniformly spaced about 1 mm to 2 mm apart.
- **Cutting-plane lines:** The location of a cutting plane is shown by this line. It is a long, thin, chain line, thick at ends only



Type of Lines

- **Leader or pointer lines:** Leader line is drawn to connect a note with the feature to which it applies. It is a continuous thin line.
- **Hidden or dotted lines:** Interior or hidden edges and surfaces are shown by hidden lines. They are also called dotted lines. They are of medium thickness and made up of short dashes of approximately equal lengths of about 2 mm spaced at equal distances of about 1 mm.
- **Centre lines:** Centre lines are drawn to indicate the axes of cylindrical, conical or spherical objects or details, and also to show the centres of circles and arcs. They are thin, long, chain lines composed of alternately long and dot spaced approximately 1 mm apart. The long dashes are about 9 to 12 mm. Centre lines should extend for a short distance beyond the outlines to which they refer.



Lettering

- Writing of titles, dimensions, notes and other important particulars on a drawing is called lettering.
- It is an important part of a drawing and tells us how accurate and neat a drawing may be drawn.

Single-stroke letters: The Bureau of Indian Standards (IS : 9609-2001) recommends single-stroke lettering for use in engineering drawing. These are the simplest forms of letters and are usually employed in most of the engineering drawings.

- The word single-stroke should not be taken to mean that the letter should be made in one stroke without lifting the pencil.
- It actually means that the thickness of the line of the letter should be such as is obtained in one stroke of the pencil.
- The horizontal lines of letters should be drawn from left to right and vertical or inclined lines, from top to bottom. Single-stroke letters are of two types:
 - (i) vertical
 - (ii) inclined

Lettering

• Inclined letters lean to the right, the slope being 75° with the horizontal. The size of a letter is described by its height. According to the height of letters, they are classified as:

- (i) Lettering 'A'
- (ii) Lettering 'B'

LETTERING A $\left(d = \frac{h}{10}\right)$

Characteristic		Ratio	Dimensions (mm)							
Lettering height										
Height of capitals	h	$\left(\frac{14}{14}\right) h$	2.5	3.5	5	7	10	14	20	
Height of lower-case letters	c	$\left(\frac{10}{14}\right) h$	-	2.5	3.5	5	7	10	14	
Spacing between characters	a	$\left(\frac{2}{14}\right) h$	0.35	0.5	0.7	1	1.4	2	2.8	
Minimum spacing of base lines	b	$\left(\frac{20}{14}\right) h$	3.5	5	7	10	14	20	28	
Minimum spacing between words	e	$\left(\frac{6}{14}\right) h$	1.05	1.5	2.1	3	4.2	6	8.4	
Thickness of lines	d	$\left(\frac{1}{14}\right) h$	0.18	0.25	0.35	0.5	0.7	1	1.4	

Lettering

LETTERING B $\left(d = \frac{h}{10}\right)$

(ii) Lettering 'B'

- Main titles are generally written in 6 mm to 8 mm size
- Sub-titles in 3 mm to 6 mm size
- Notes, dimension figures etc. in 3 mm to 5 mm size.
- Drawing number in the title block is written in numerals of 10 mm to 12 mm size.

Characteristic		Ratio	Dimensions (mm)						
Lettering height									
Height of capitals	h	$\left(\frac{10}{10}\right) h$	2.5	3.5	5	7	10	14	20
Height of lower-case letters	c	$\left(\frac{7}{10}\right) h$	-	2.5	3.5	5	7	10	14
Spacing between characters	a	$\left(\frac{2}{10}\right) h$	0.5	0.7	1	1.4	2	2.8	4
Minimum spacing of base lines	b	$\left(\frac{14}{10}\right) h$	3.5	5	7	10	14	20	28
Minimum spacing between words	e	$\left(\frac{6}{10}\right) h$	1.5	2.1	3	4.2	6	8.4	12
Thickness of lines	d	$\left(\frac{1}{10}\right) h$	0.25	0.35	0.5	0.7	1	1.4	2

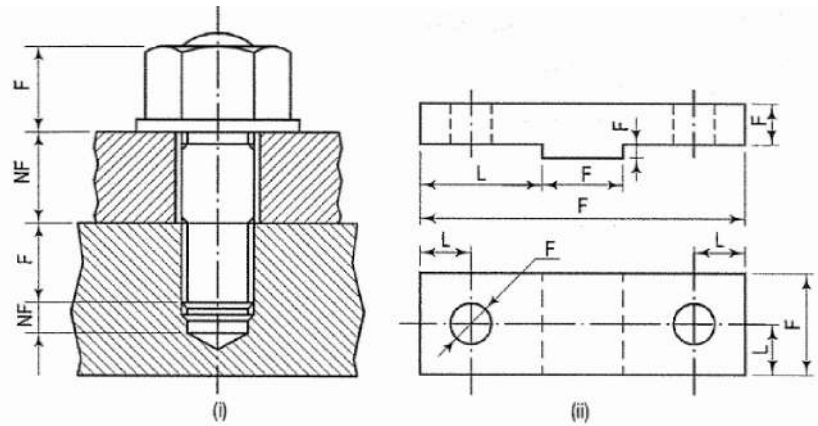
Dimensioning

Every drawing, whether a scale drawing or a freehand drawing, besides showing the true shape of an object, must supply its exact length, breadth, height, sizes and positions of holes, grooves etc. and such other details relating to the manufacture of that object.

- Providing this information on a drawing is called dimensioning. Lines, figures, numerals, symbols, notes etc. are used for this purpose.

- Types of dimensions: Two types of dimensions needed on a drawing are: (i) size or functional dimensions and (ii) location or datum dimensions (shown by letters F and L respectively).

- The former indicate sizes, viz. length, breadth, height, depth, diameter etc. The latter show locations or exact positions of various constructional details within the object. The letter F represents functional dimensions, while NF represents non-functional dimensions

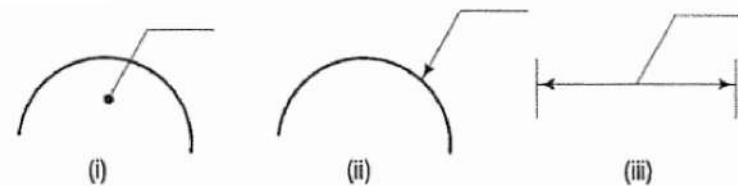
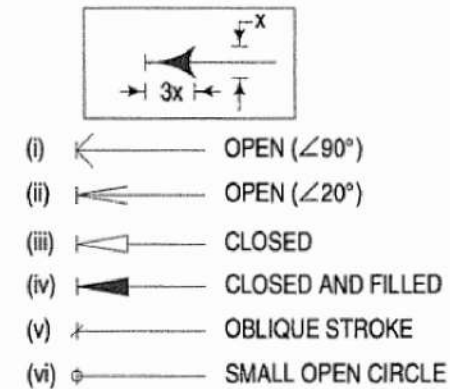
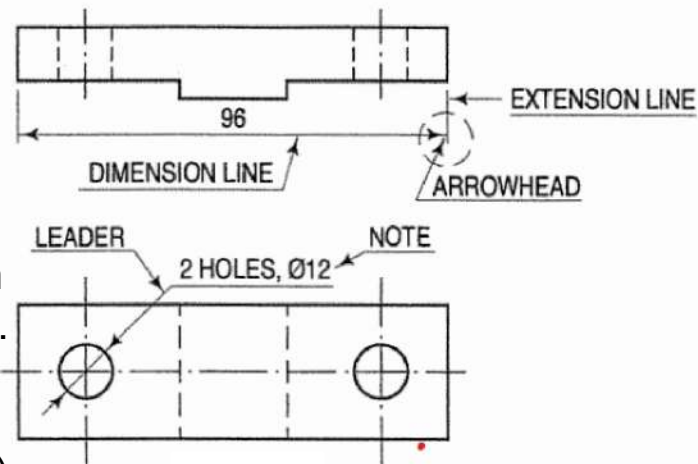


Dimensioning Terms and Notations

•**Dimension line:** Dimension line is a thin continuous line. It is terminated by arrowheads touching the outlines, extension lines or centre lines.

•**Extension line:** An extension line is also a thin continuous line drawn in extension of an outline. (Formerly, the 8.1.S. had recommended that a gap of about 1 mm should be kept between the extension line and an outline or object boundary.) It extends by about 3 mm beyond the dimension line.

Arrowhead: An arrowhead is placed at each end of a dimension line. Its pointed end touches an outline, an extension line or a centre line. The size of an arrowhead should be proportional to the thickness of the outlines. The length of the arrowhead should be about three times its maximum width.



Dimensioning Terms and Notations

•**Leader:** A leader or a pointer is a thin continuous line connecting a note or a dimension figure with the feature to which it applies. One end of the leader terminates either in an arrowhead or a dot. The arrowhead touches the outline, while the dot is placed within the outline of the object

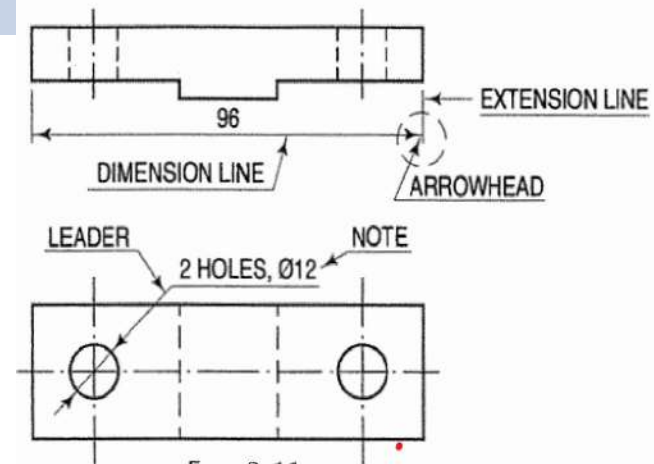


FIG. 3-11

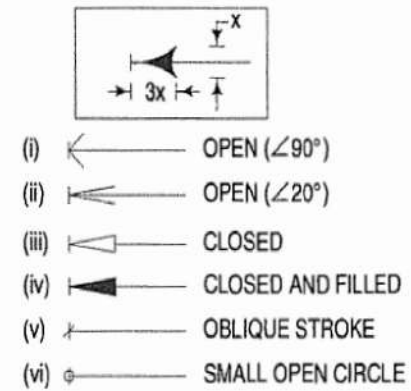
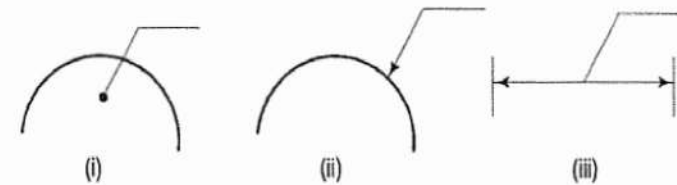


FIG. 3-11(a)

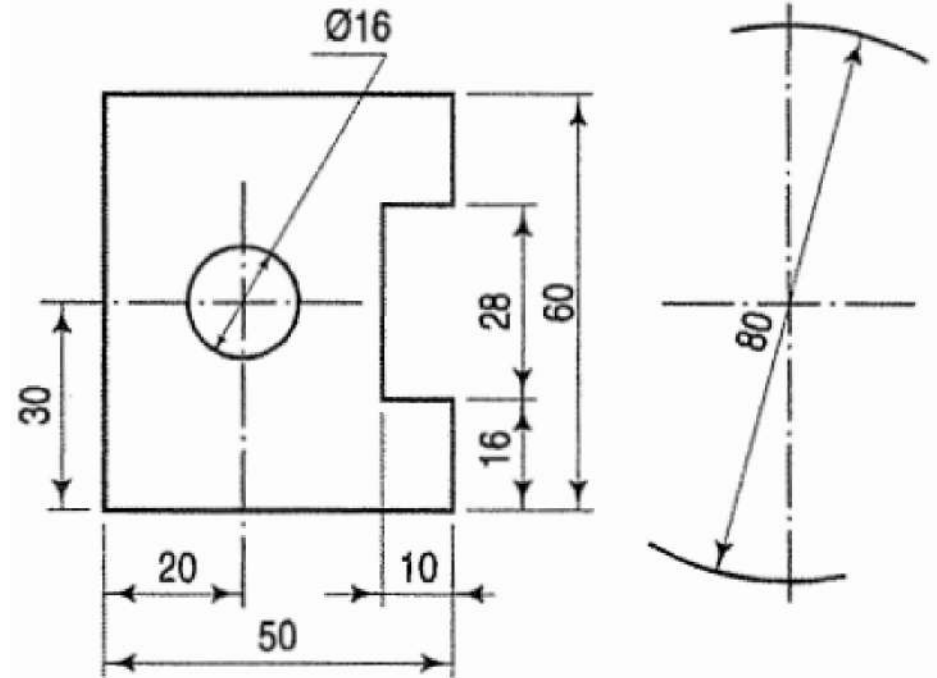


Placing of Dimensions

The two systems of placing dimensions are: (1) Aligned system and (2) Unidirectional system.

Aligned system:

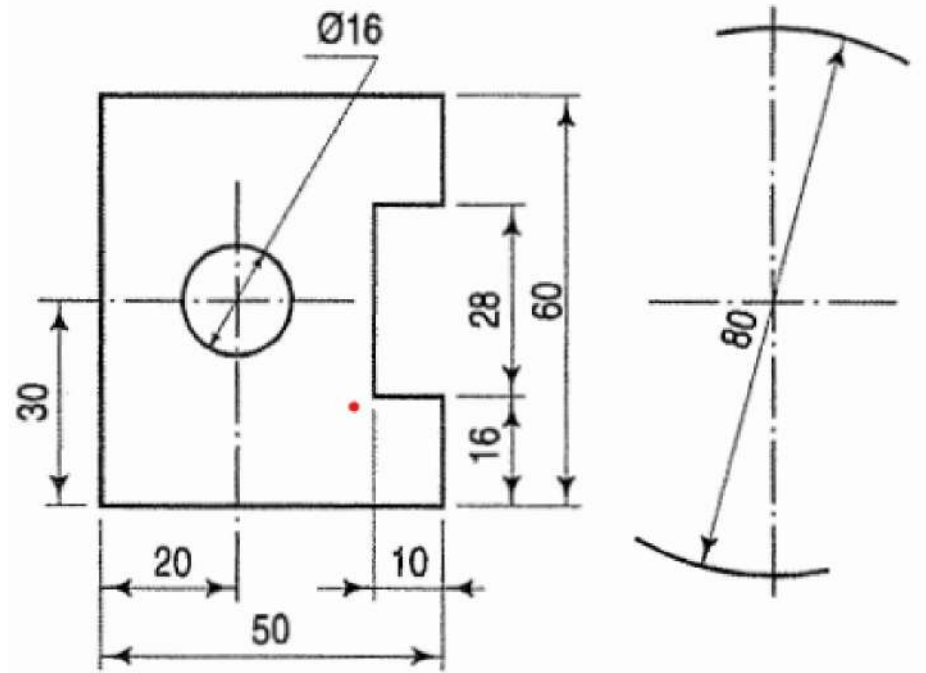
- In the aligned system the dimension is placed perpendicular to the dimension line in such a way that it may be read from the bottom edge or the right-hand edge of the drawing sheet.
- The dimensions should be placed near the middle and above, but clear of the dimension lines.



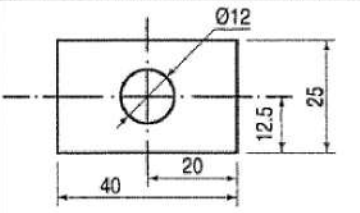
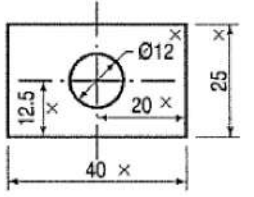
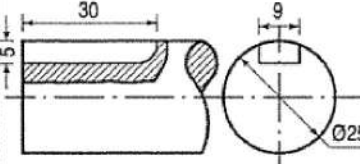
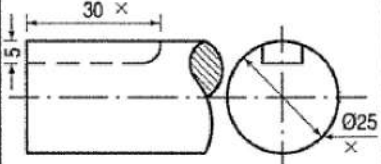
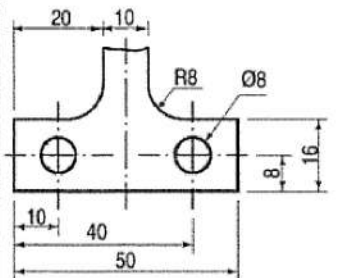
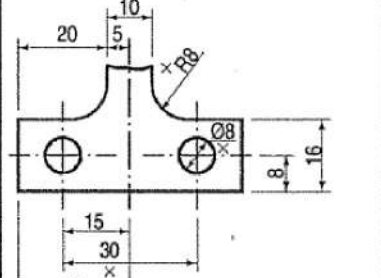
Placing of Dimensions

Unidirectional System:

- In unidirectional system all dimensions are so placed that they can be read from the bottom edge of the drawing sheet.
- The dimension lines are broken near the middle for inserting the dimensions.
- This system is mainly used on large drawings - as of aircrafts, automobiles etc. where it is inconvenient to read dimensions from the right-hand side.



Placing of Dimensions

	CORRECT	INCORRECT	REASONS FOR INCORRECT
(i)	 <p>Dimensions should be placed outside view</p>		<ol style="list-style-type: none"> 1. Arrow head not proportionate. 2. Hole dimension shown in figure. Leader line not ends horizontally. 3. Dimension '40' is too close. 4. Placing dimensions methods mix. Dimension '40' is according to aligned method.
(ii)	 <p>Dim. should be marked from visible outlines</p>		<ol style="list-style-type: none"> 1. A key-way is shown with dotted line where the dimensions are placed. 2. Leader line for the shaft diameter is drawn horizontal touching the boundary line.
(iii)	 <p>Dimensions should be given from the outlines (finished surface) or a centre line of a hole</p>		<ol style="list-style-type: none"> 1. Dimensions are given from the mid-line of the object. 2. Dimensions of holes are shown inside the figure. 3. Dimensions are shown in vertical line. 4. Smaller dimensions (25 mm) precedes the larger dimensions (30 mm). 5. Fillet radius is not shown.

Placing of Dimensions

Fill-in the blanks with appropriate words selected from the list given below:

- (a) Writing of titles, notes etc. on a drawing is called _____.
- (b) Efficiency in the art of lettering is achieved by continuous _____.
- (c) Lettering should be in plain and simple style so that it could be done _____ and _____.
- (d) For maintaining uniformity in size, thin and light _____ may first be drawn.
- (e) All letters should be uniform in _____, _____, _____, _____ and _____.
- (f) The inclined letters slope to the _____ at an angle of _____ degrees.
- (g) The size of the letter is described by its _____.
- (h) Main title of inked drawing is generally written in _____ letters.
- (i) The two types of single-stroke letters are _____ and _____.
- (j) Lettering is usually done in _____ letters.
- (k) Lower-case letters are usually used in _____ drawings.
- (l) Lettering should be so done as can be read from the _____ with the main title _____.

List of words for

- | | | |
|--------------------------|-------------------------|------------------------|
| 1. Inclined | 2. Shade | 3. Horizontal |
| 6. Vertical | 7. Freehand | 8. Shape |
| 11. Right | 12. Front | 13. Guide lines |
| 16. Practice | 17. Lettering | 18. Spacing |
| 4. Speedily | 5. Height | |
| 9. Gothic | 10. Seventy five | |
| 14. Slope | 15. Capital | |
| 19. Architectural | 20. Size. | |

Placing of Dimensions

Complete each statement given in A, by selecting an appropriate one from those given in B:

- A
- (a) Outlines or principal lines are drawn as _____
 - (b) Lines for hidden edges are drawn as _____
 - (c) Thin and long chain line is made up of _____
 - (d) Centre lines, locus lines and pitch circles are drawn as _____
 - (e) Dashed line of medium thickness is made up of _____
 - (f) Dimension lines, hatching and extension lines are drawn as _____
 - (g) The position of cutting plane is shown by _____
 - (h) Irregular boundaries and short breaks are shown by _____
 - (i) Long breaks are shown by _____
- B
- (1) long and thin chain lines
 - (2) thick and long chain line, thick at ends only
 - (3) thick continuous lines
 - (4) short dashes of approximately equal lengths
 - (5) thin continuous lines
 - (6) continuous, thin and wavy lines, drawn freehand
 - (7) thin ruled lines with short zigzags within them
 - (8) alternately long and short dashes
 - (9) dashed lines of medium thickness.