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CHAPTER 1

1. INTRODUCTION & DEMONSTRATION

1.1 Identify various sizes of drawing boards, drawing sheets as per BIS.

1.2 List the types of pencils, instruments, and scales (RF).

1.3 Demonstrate lying of drawing sheet, margin, standard layout and title block as per BIS, folding principle of drawings (blue prints, print outs etc).

1.1 INTRODUCTION & DEMONSTRATION

Engineering drawing is a two dimensional representation of three dimensional objects. In general, it provides necessary information about the shape, size, surface quality, material, manufacturing process, etc. of the object. It is the graphic language from which a trained person can visualize objects.

1.2 LIST OF INSTRUMENTS USED IN DRAWING:-

The Instruments and other aids used in drafting work are listed below:

1. Pencil
2. Drawing board
3. Setsquare
4. Mini drafter
5. Instrument box
6. Protractor
7. Measurement Scale
8. Drawing sheet
9. Drawing clips or Drawing pins

1. Pencils :

Pencils with leads of different degrees of hardness or grades are available in the market. The hardness or softness of the lead is indicated by 3H, 2H, H, HB, B, 2B, 3B, etc.

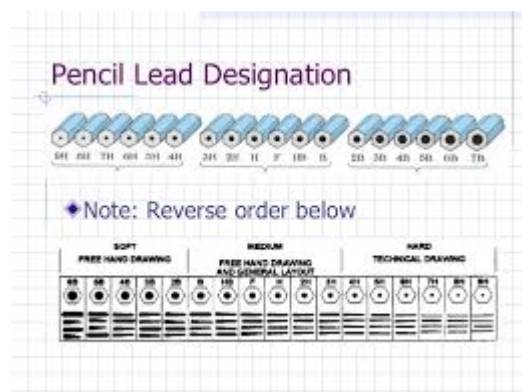
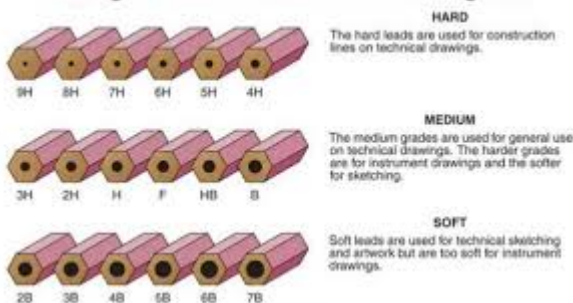
The grade HB denotes medium hardness of lead used for general purpose.

The hardness increases as the value of the numeral before the letter H increases.

The lead becomes softer, as the value of the numeral before B increases.

1. HB Soft grade for Border lines, lettering and free sketching
2. H Medium grade for Visible outlines, visible edges and boundary lines
3. 2H Hard grade for construction lines, Dimension lines, Leader lines, Extension lines, Centre lines, Hatching lines and Hidden lines.

• Drawing Pencils are made in different grades.



2. Drawing Board :

Drawing board is one of the main equipment of Draughtsman. It is used for supporting the drawing paper/tracing paper for making drawings. It is made of well seasoned wood strips of about 25 mm thick, free from knots and warping. It should be softer enough to allow insertion and removal of drawing pins. Two battens are fastened to the board by screws, in slotted joints. They prevent warping and at the same time permit expansion and contraction of the strips due to the change of moisture in the atmosphere

One of the shorter edges of the drawing board is provided with an “ebony edge” (hard wood) fitted perfectly straight. Standard drawing boards are designated as follows in Table 1.1 as per IS: 1444-1989.

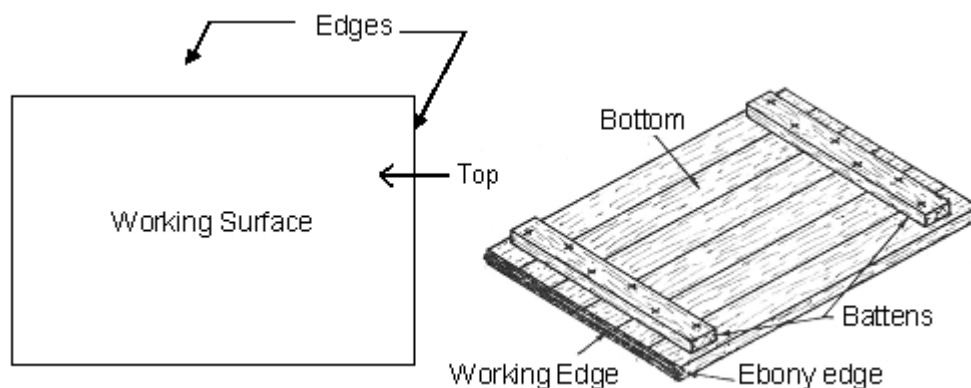
Designation Size (mm)

D0 1500 x 1000 x 25

D1 1000 x 700 x 25

D2 700 x 500 x 15

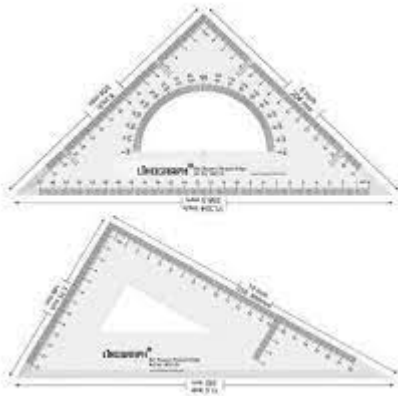
D3 500 x 350 x 15



The working edge (ebony) must be straight. Now-a-days the drawing boards are available with laminated surfaces. The flatness can be checked by placing a straight edge on its surface. If no light passes between them, the surface is perfectly flat.

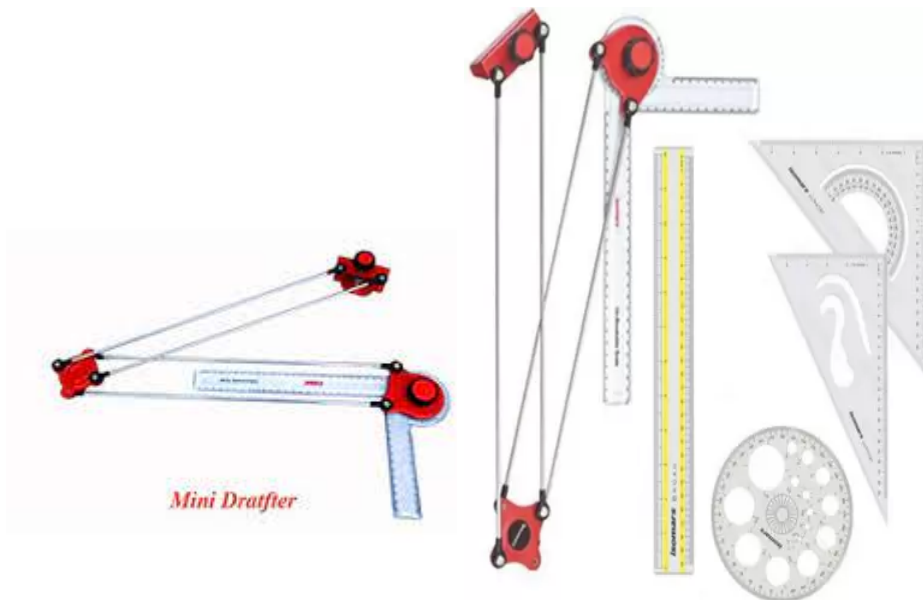
3. Set Square :

They are used to construct the most common angles (i.e. 300 , 450 and 600) in technical drawings. The 450 x 450 and 300 x 600 triangles are the most commonly used for ordinary work.



4. Mini-Drafter :

Mini-drafter consists of an angle formed by two arms with scales marked and rigidly hinged to each other. It combines the functions of T-square, set-squares, scales and protractor. It is used for drawing horizontal, vertical and inclined lines, parallel and perpendicular lines and for measuring lines and angles.



5. Instrument Box:

Instrument box contains

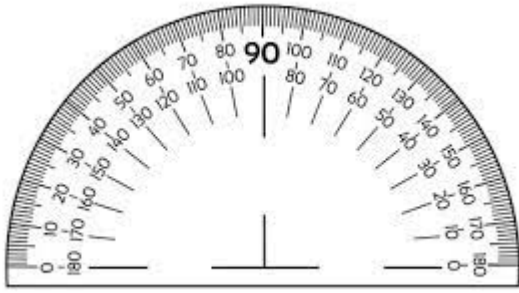
- i. Compasses,
- ii. Dividers
- iii. Inking pens.



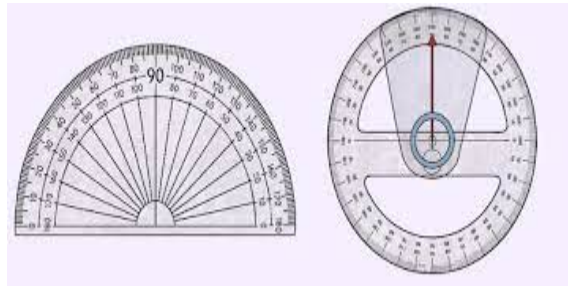
The important point is the position of the pencil lead with respect to the tip of the compass. It should be at least 1 mm. Because the tip goes into the board for grip by 1mm.

6. Protractor:

Protractors are used for constructing and measuring angles. Protractors are generally semicircular in shape. The base diameter of the semicircle serves as the straight edge. A semicircular protractor can measure angles of any measure between 0° to 180° . Least count of the protractor is generally 10° . A square protractor is also made of transparent celluloid or plastic material.

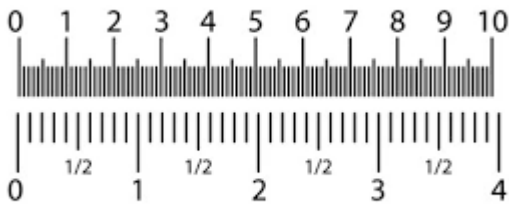


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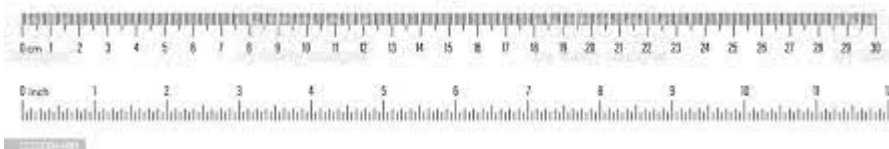
7. Measurement Scale:

A number of kinds of scales are available for varied types of engineering design. Scales with beveled edges graduated in mm are usually used. Least count of such scales is generally 1 mm.



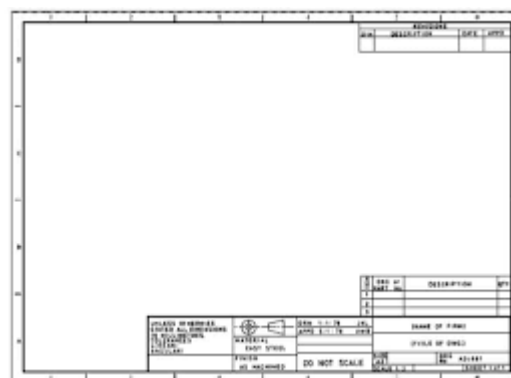
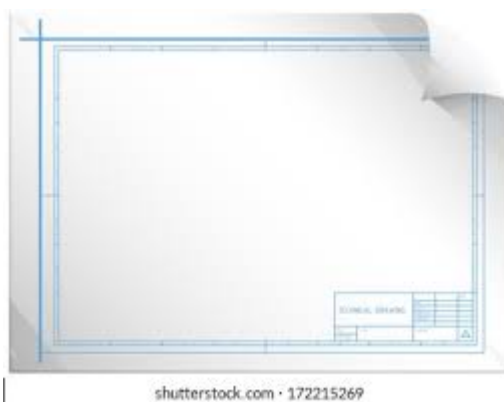
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inch / cm



8. Drawing Sheet:

These are of two types: Hand-made paper Mill-made paper
Hand-made papers have rough surfaces, pale in colour and not used for regular work, but meant for charts. Mill-made papers are most commonly used for regular work, and are available in different sizes and rolls. They are specified by their weight in kg per ream or density in grams per square meter. Size of drawing sheets (in mm): While working or handling, the papers are liable to tear on the edges. So slightly large size (untrimmed) sheets are preferred. They are trimmed afterwards. IS: 10811:1983 lays down such as designation of preferred trimmed and untrimmed sizes. The basic principle involved in arriving at the sizes of the drawing paper is as under. The area of the biggest size (A0) is 1m² and its length and breadth are in the ratio 1:2 = (1/2). Designation of sheets : The drawing sheets are designated by symbols such as A0, A1, A2, A3, A4 and A5. A0 being the largest. Table 1.2 below gives the length and breadth of the above sizes of sheets. For class work use of A2 size drawing sheets is preferred.



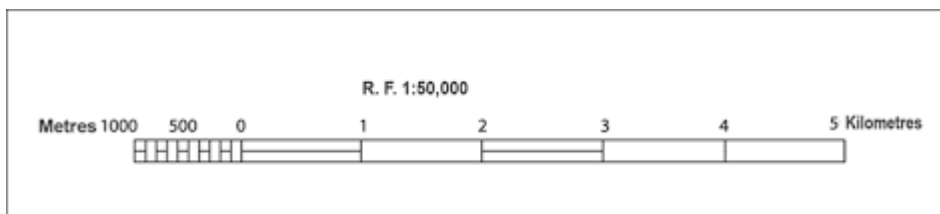
9. Drawing Clips or Drawing Pins :

They are used to fix the drawing sheet firmly in position to the drawing board as one constructs the drawing. Both drawing clips and drawing pins serve the same purpose. They are generally made up of steel or plastic.



1.3 SCALE (R.F) :

Dimensions of large objects must be reduced to accommodate on standard size drawing sheet. This reduction creates a scale of that reduction ratio, which is generally a fraction & such a scale is called Reducing Scale and the ratio is called Representative Factor.



SCALE (R.F) :

RF = Dimension of drawing \

Dimension of object

= Length of object in drawing \ Actual length

Note :

For computing R.F, the numerator and denominator should be in same units. 1.4 STANDARD LAYOUT OF DRAWING SHEET: The layout of a drawing sheet used on the shop floor

1.5 FOLDING PRINCIPLE OF DRAWINGS

Method of folding of printed drawing sheets as per BIS SP: 46-2003:

When drawing sheets are in more numbers, they have to be folded and kept in order to save the trace required for preserving them .

Requirement While folding the drawings following care to be taken.

1. It is required to fold the drawing sheets such that, they should not get defaced or damaged.
2. Drawing sheet to be folded such that the title block is easily visible to retrieve it .

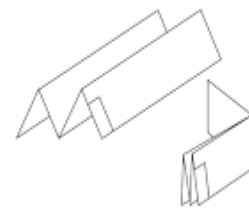


1.6 TITLE BLOCK :

The title block should lie within the drawing space at the bottom right hand corner of the sheet.

The title block can have a maximum length of 185 mm and width of 65 mm providing the following information.

- Title of the drawing.
- Drawing number.
- Scale.
- Symbol denoting the method of projection.
- Name of the firm,
- Initials of staff, who have designed, checked and approved.



CHAPTER 2









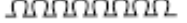
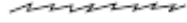


TYPES OF LINES, LETTERING & DIMENSIONING

- 2.1 Demonstrate and explain the use of various types of lines.
- 2.2 Demonstrate the principle of single stroke, gothic lettering & numerals as per BIS.

2.1 Demonstrate and explain the use of various types of lines.

TYPES OF LINES, LETTERING & DIMENSIONING

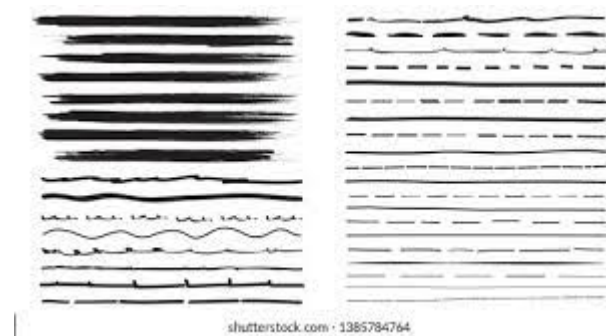
Line is one important aspect of technical drawing. Lines are always used to construct meaningful drawings. Various types of lines are used to construct drawing, each line used in some in a specific sense. Lines are drawn following standard conventions mentioned in BIS (SP46:2003). A line may be curved, straight, continuous, segmented. It may be drawn as thin or thick.

Types of Lines	
Dots	
Circle chain	
Zig-zag	
Dashes	
Clouds	
Hills	
Loops	
Waves	
Mouse ears	
Lighting	
Swirl	
Castle	

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Line Strokes

Line strokes refer to the directions of drawing straight and curved lines. Vertical and inclined lines are drawn from top to bottom, horizontal lines are drawn from left to right. Curved lines are drawn from left to right or top to bottom



2.2 Demonstrate the principle of single stroke, gothic lettering & numerals as per BIS.

Single Stroke Letters

The word single-stroke should not be taken to mean that the lettering should be made in one stroke without lifting the pencil. It means that the thickness of the letter should be uniform as if it is obtained in one stroke of the pencil.

Single-stroke letters are of *two* types:

- i. Vertical
- ii. Inclined. (Inclined letters lean to the right, the slope being 75° with the horizontal)

According to the height of letters, they are classified as:

i. Lettering 'A'

ii. Lettering 'B'

In lettering 'A' type, the height of the capital letter is divided into 14 parts, while in lettering

'B' type is divided into 10 parts. The height of the letters and numerals for engineering drawing

can be selected from 2.5, 3.5, 5, 7, 10, 14 and 20 mm according to the size of drawing. **The ratio**

height to width varies but in most of the letters it is 6 : 5.

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

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

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

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

Fig 2.4

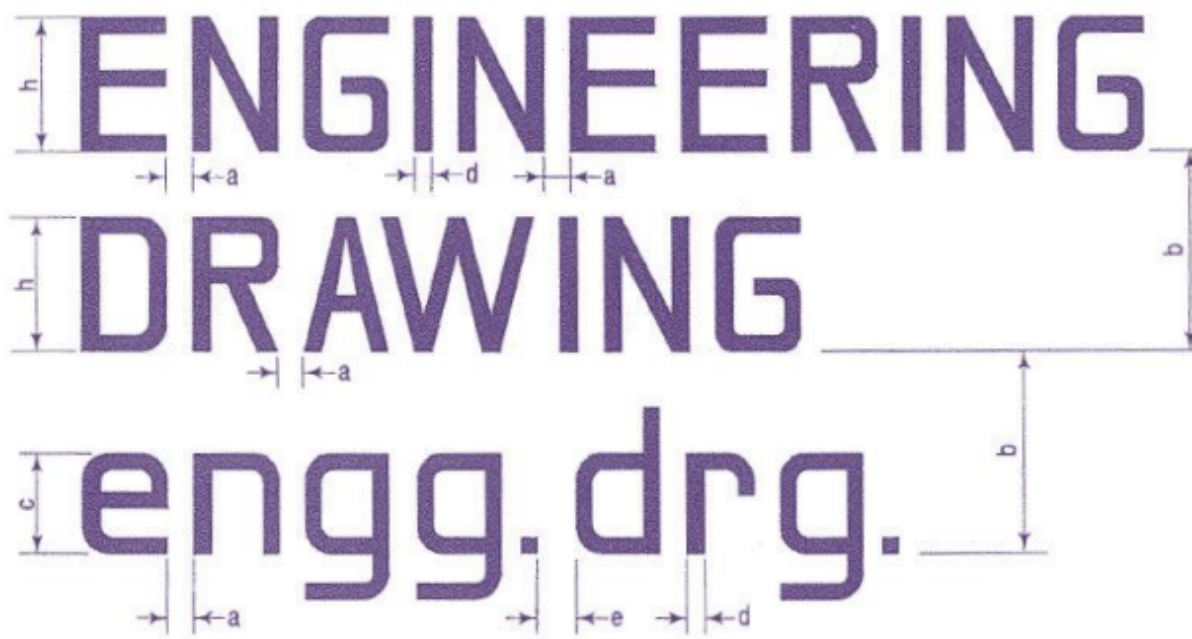


Fig 2.5 Single-stroke vertical capital letters and figures :



Fig 2.6 Single-stroke inclined capital letters and figures:



Fig 2.7 Single-stroke vertical & inclined lower case letters and figures :

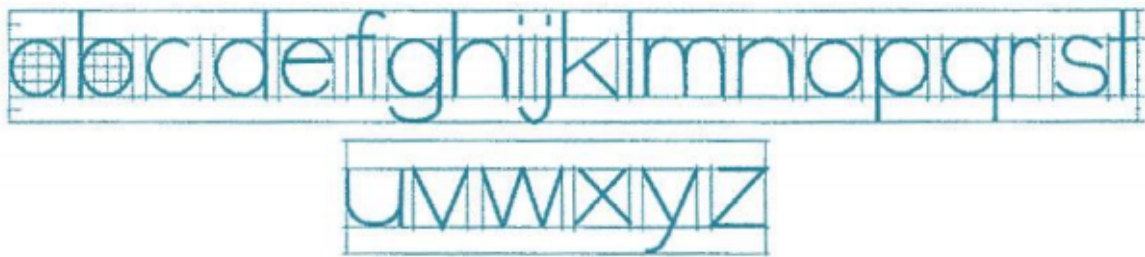
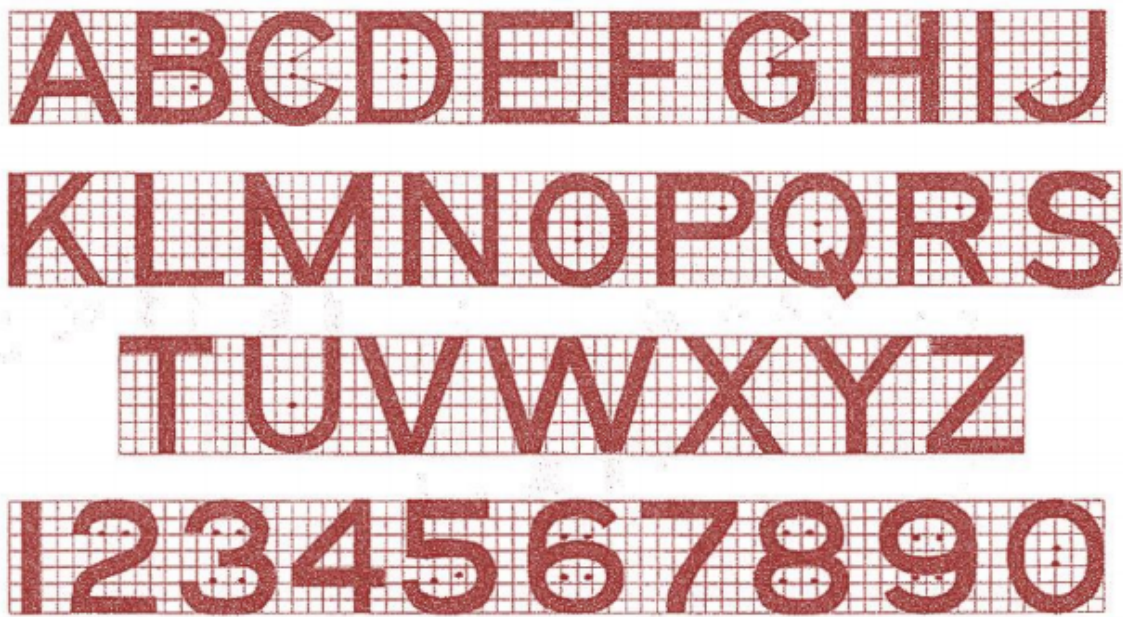


Fig 2.8

Gothic letters:

Stems of single-stroke letters, if given more thickness, form what are known as *gothic* letters. The thickness of the stem may vary from $\frac{1}{5}$ to $\frac{1}{10}$ of the height of the letters



Here stem thickness is taken as $1/7$ times height.

Dimensioning

Dimensioning is the process of specifying part's information by use of lines, numbers, symbols and notes.

The general principle of dimensioning :

As far as possible, it should be placed outside the view.

It should be taken from a visible line rather than hidden lines.

Dimensioning of a centre line should be avoided except when the centre line passes through the centre of a-holes.

The dimension should be placed on the view or section which is most clear to the corresponding features.

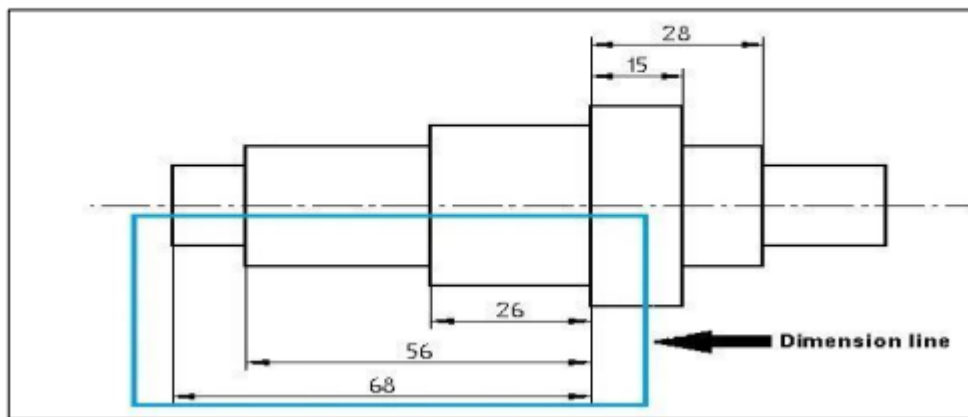
Each dimension should be dimensioned once on a drawing.

Each drawing should have the same dimensional unit.

More than one dimension should not be used for features of the same parts.

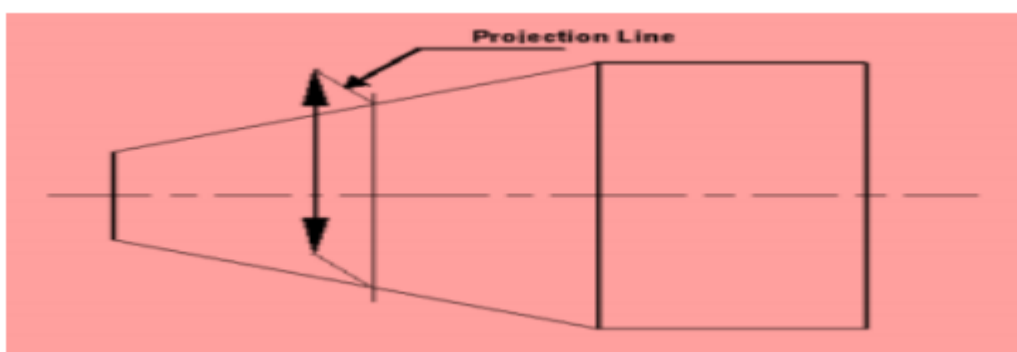
Elements of Dimensioning

Dimension Line: Dimension line is a continuous thin line. It is indicated by arrowheads, it is drawn parallel to the surface whose length must be indicated.



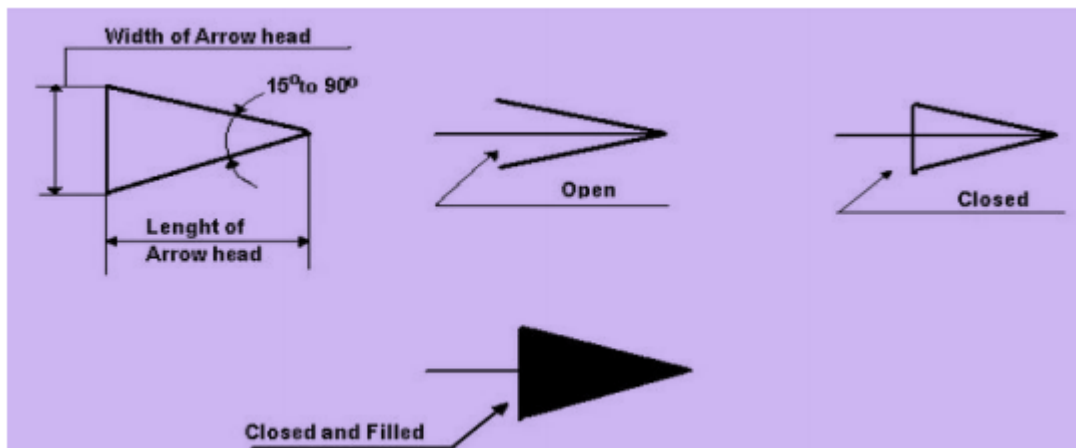
Projection or Extension Line :

A projection line or extension line, it is a thin line. It is drawn perpendicular to the surface which is to be dimensioned. The projection line slightly extends than the dimension line



Construction line: A construction line is a thin line drawn to indicate the dimension line. The construction line is extended slightly beyond the point intersection.

Arrowheads: Arrowheads are used to indicate the dimension line. Usually, the arrowhead must have inclined angles of a minimum of 15° . The Arrowhead may be open or close or closed and filled.



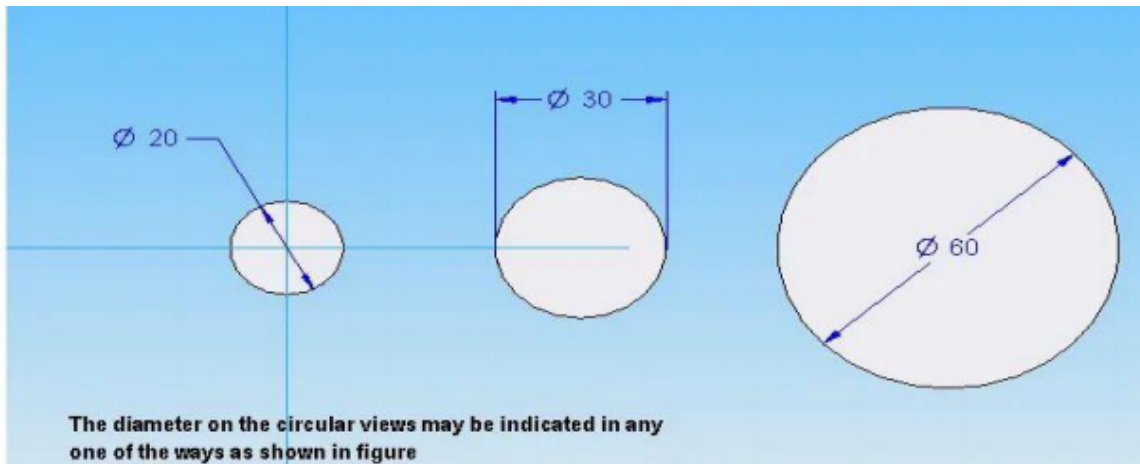
Leader or Pointer Lines: These are thin continuous lines drawn from a dimension figure to the feature to which it refers. Leader line is drawn may be 30° or 60° to the bottom of dimensions.

Dimension Figure: These are drawn may be vertical or inclined to indicate the height of the dimension figure.

Units of Dimensions

The dimension unit is millimetre. The unit of the dimension is omitted while writing the dimension fig. and a footnote stating “**ALL DIMENSIONS ARE IN MM**” is written at the prominent place on the drawing sheet.

Dimensioning common features



Dimensioning Radius :

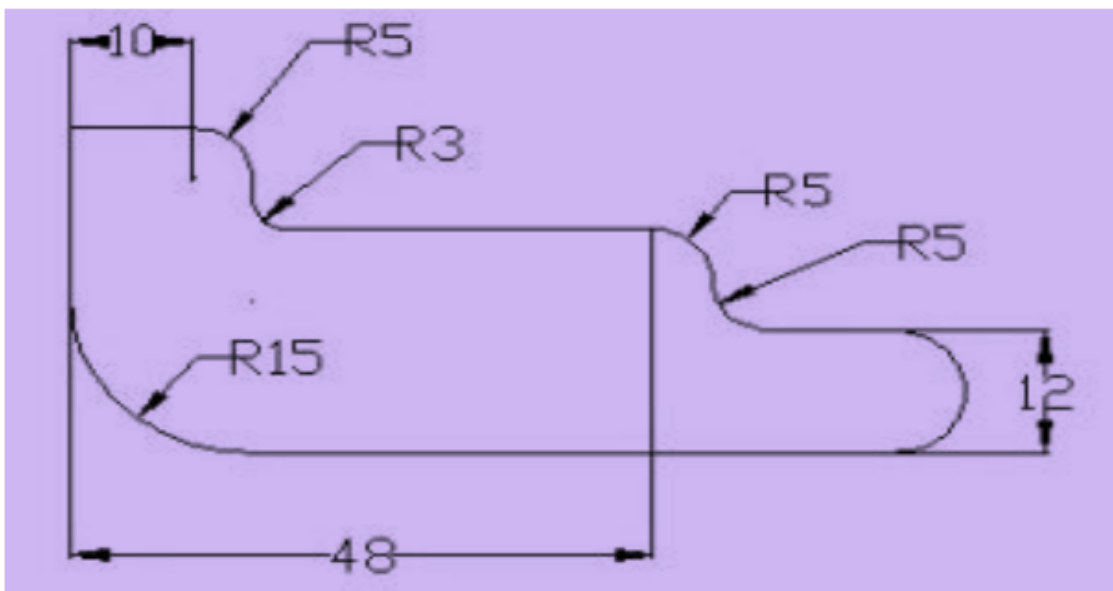
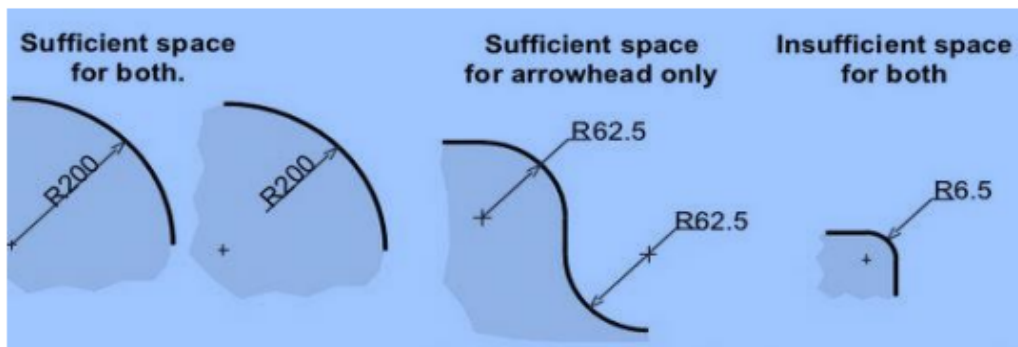


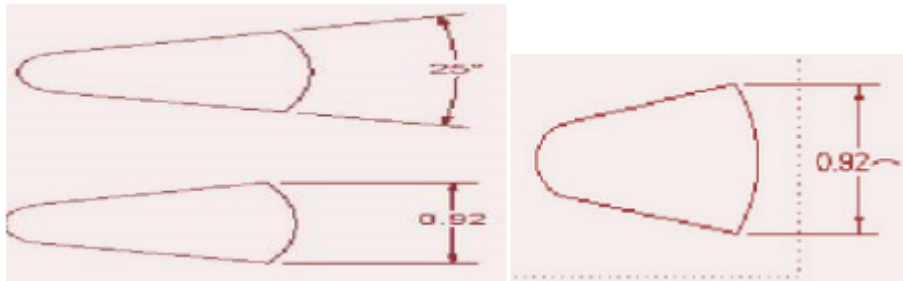
Fig 2.14

Dimensioning Arcs :



Dimensioning Chords :

It is a linear distance between any two points of an arc.



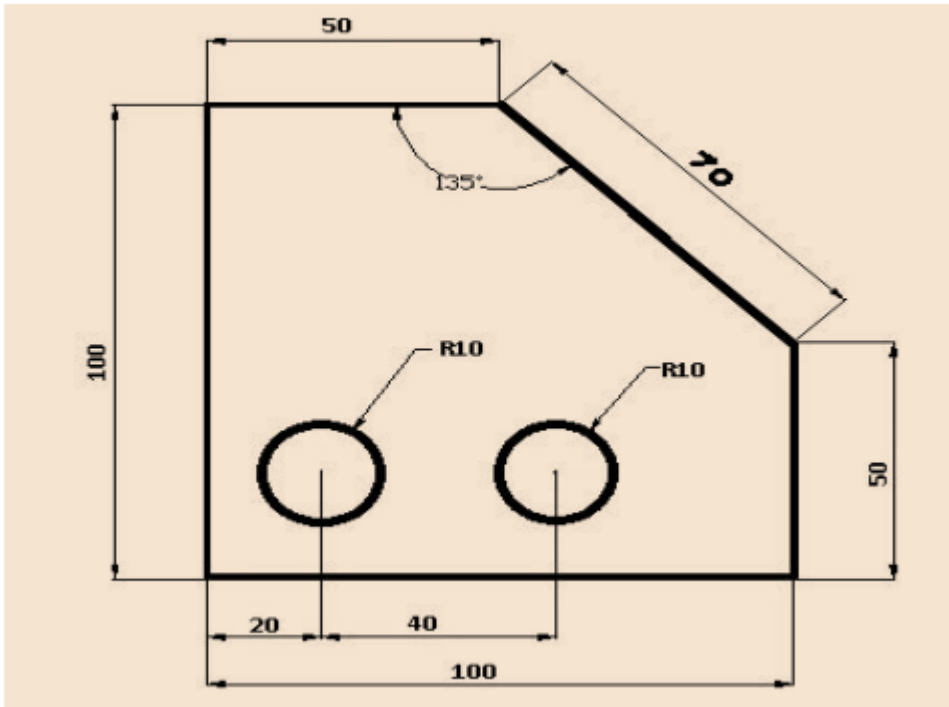
Dimensioning Angles :



Types of Dimensioning systems:

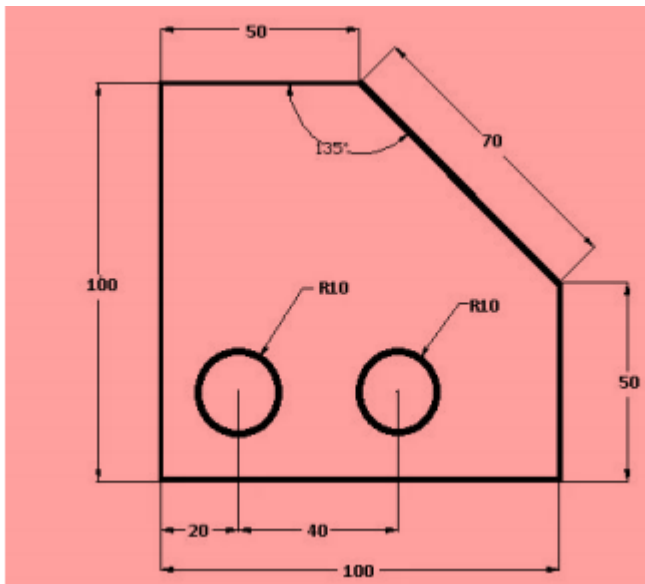
Aligned System :

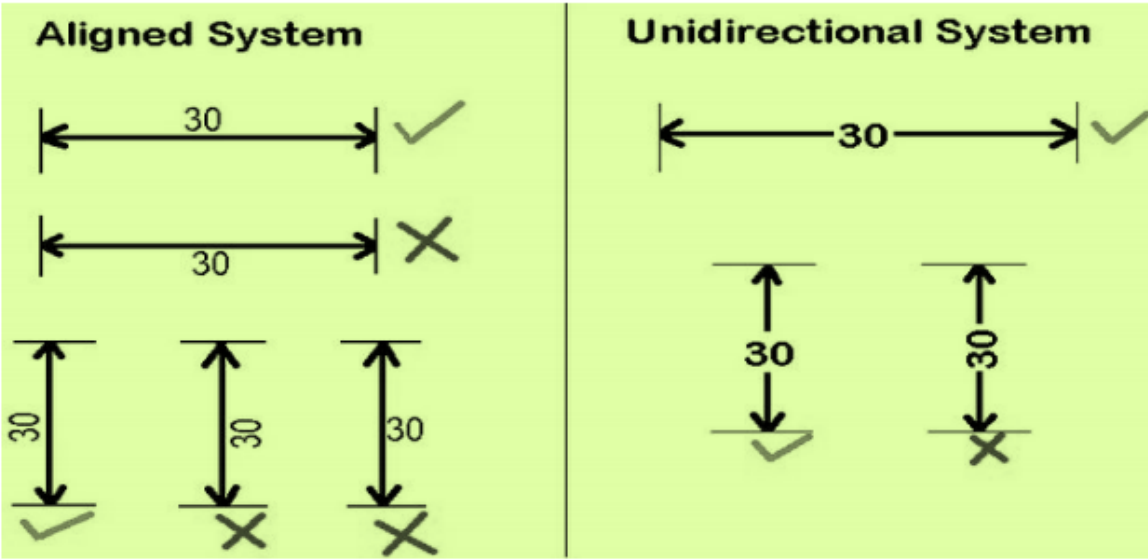
In this type of dimensioning systems, Dimensions are placed above the dimension lines which are drawn without any break and written parallel to them.



Unidirectional System:

Dimensions are inserts by breaking the dimension lines in the middle.





CHAPTER 3

SCALES

3.1 Significance of scales in drawing;
different scales.

3.2 Define and draw plain scale and
diagonal scale.

Introduction

A scale is defined as the ratio of the linear dimensions of the object as represented in a drawing to the actual dimensions of the same.

It is not always possible to make drawings of an object to its actual size. If the actual linear dimensions of an object are shown in its drawing, the scale used is said to be a full size scale.

Wherever possible, it is desirable to make drawings to full size.

Purpose of Scale

Scales are used for the following purposes :

1. To prepare a drawing on a reduced scale so that large object can be accommodated on the limited size of drawing sheet.
e.g. building, machine parts etc.
2. To prepare the drawing of very small objects.
e.g. parts of wrist watches, measuring instruments etc. on enlarged scales in order to give better understanding and to study the details of the minor parts of the objects.
3. To measure linear measurements of the object under measurement directly without involving any calculations.
4. To measure and set off dimensions as per scales decided upon or given before starting the drawing.

Types of scale :

3.3.1 Reducing Scale:

It is the scale in which the actual measurements of objects are reduced and represented on the drawing sheet.

Generally the drawings are very big objects like buildings, machine parts; town plans etc are prepared on a reduced scale.

The standard proportions are :

1:2, 1:5, 1:10, 1:20, 1:50, 1:100, 1:200, 1:500, 1:1000, 1:2000, 1:5000, 1:10000

for this scale, $RF < 1$

Example-If the actual size of the object is 100cm then using R.F. of 1:10, the size of the object would be $100 \times (1/10) = 10\text{cm}$ in drawing.

3.3.2 Full Size Scale :

In this scale the actual measurements of the objects are represented on the drawing. In this scale the usual proportion is 1:1. For this scale $R.F. = 1$

Example- If the actual size of the object is 150cm then using R.F. of 1:1, the size of the object would be $150 \times (1/1) = 150\text{ cm}$ in drawing.

3.3.3 Enlarging Scale :

It is the scale in which the actual measurements of the objects are increased in some proportion to accommodate object details on the drawing sheet.

Generally the drawings of very small objects like watches, electronic devices, precision instruments etc. are prepared in an enlarging scale. The standard enlarging scales are :

50:1, 20:1, 10:1, 5:1, 2:1 for this scale, R.F.>1

Example- If the actual size of the object is 2cm then using R.F. of 50:1, the size of the object would be $2 \times (50/1) = 100\text{cm}$ in drawing.

Representative Fraction (R.F.)

The ratio of the dimension of the object shown on the drawing to its actual size is called the Representative Fraction (R.F.).

Mathematically S.F or R.F = $\frac{\text{Distance of the object on drawing}}{\text{Actual distance of the object}}$

Both in same units

3.5

UNITS OF MEASUREMENTS

Metric measures :

i. Linear Measures

1 KILOMETRE = 10 HECTOMETRES
1 HECTOMETRE = 10 DECAMETRES
1 DECAMETRE = 10 METRES
1 METRE = 10 DECIMETRES
1 DECIMETRE = 10 CENTIMETRES
1 CENTIMETRE = 10 MILIMETRES

Classification of Scales

The scales used in engineering drawing are classified as follows:

i. Plain scale or simple scale

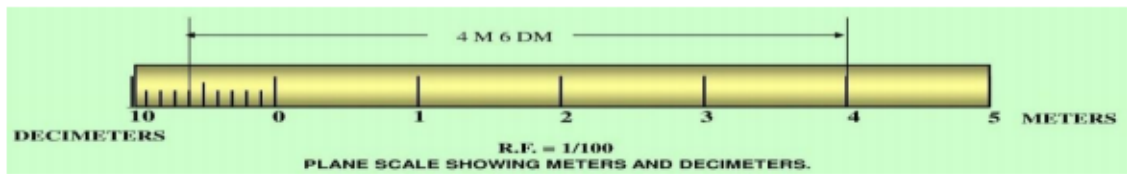


Fig 3.1

ii. Diagonal scale

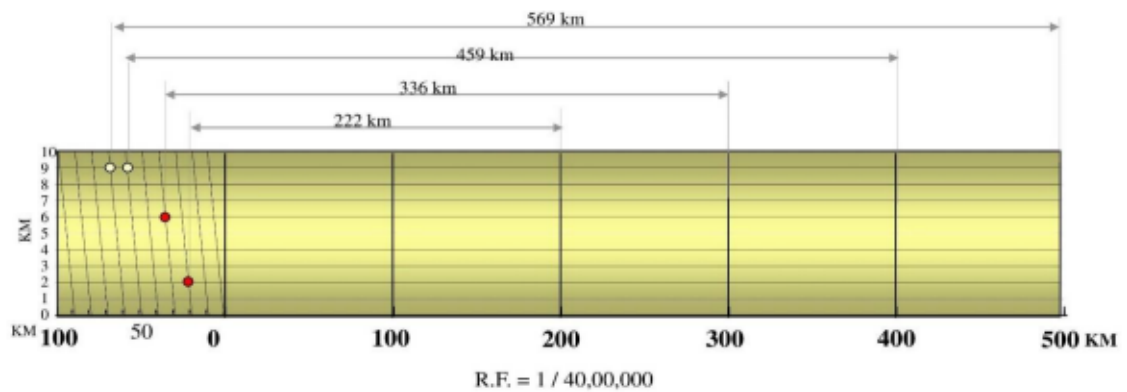


Fig 3.2

iii. Comparative or Corresponding Scale

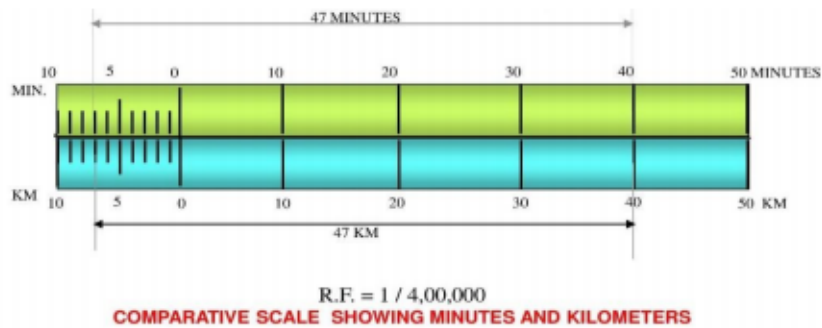
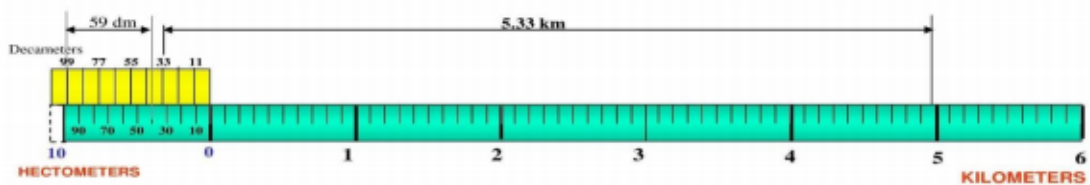
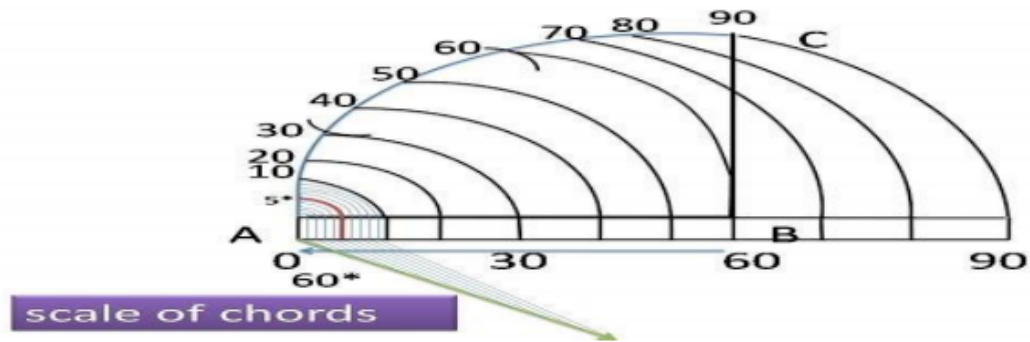


Fig 3.3

iv. Vernier Scale



v. Scale of chords



3.5

Plain Scale

This type of scale represents two units or a unit and its subdivision.

Q. No. 1.

Draw a scale 1 cm = 1m to read decimeters, to measure maximum distance of 6 m. Show on it a distance of 4 m and 6 dm

CONSTRUCTION :

a. Calculate R.F. = (DIMENSION OF DRAWING / DIMENSION OF OBJECT)

$$\text{R.F.} = 1\text{cm} / 1\text{m} = 1/100$$

$$\text{Length of scale} = \text{R.F.} \times \text{max. distance} = (1/100) \times 600\text{ cm} = 6\text{ cm}$$

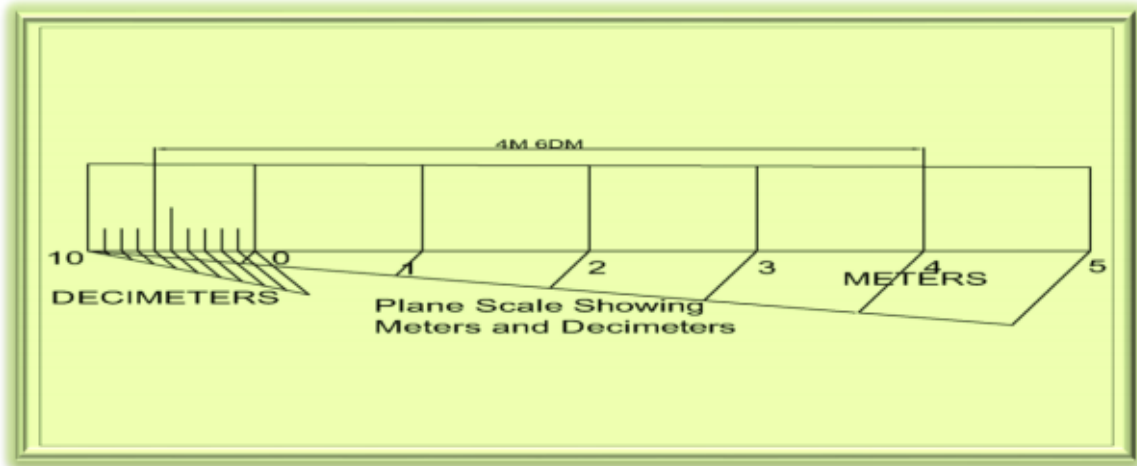
b. Draw a line 6 cm long and divide it in 6 equal parts. Each part will represent a larger division unit.

c. Sub-divide the first part which will represent the second unit or fraction of the first unit.

d. Place (0) at the end of the first unit. Number the units on right side of Zero and subdivisions on left hand side of Zero. Take the height of scale 5 to 10 mm for getting a look of scale.

e. After construction of scale, mention its RF and name of scale as shown.

f. Show the distance 4 m 6 dm on it as shown Fig



CHAPTER 4

CURVES

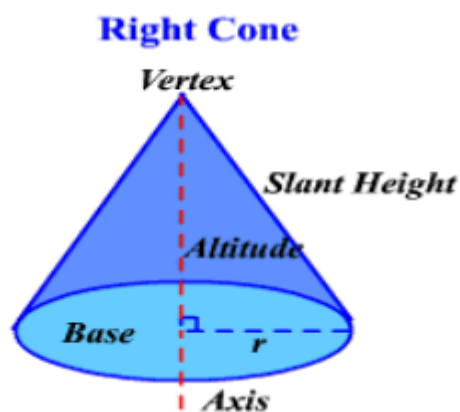
- 4.1 Explain Conic sections with illustration, Explain terms like focus, vertex, directrix and eccentricity.
- 4.2 Draw conics sections by eccentricity method – Ellipse, Parabola and Hyperbola.
- 4.3 Draw Ellipse by concentric circle method and arc of circle method.
- 4.4 Draw parabola by Rectangle Method and Tangent Method.

4.1 Explain Conic sections with illustration, Explain terms like focus, vertex, directrix and eccentricity

CONIC SECTIONS

Cone is formed when a right angled triangle with an apex and angle θ is rotated about its altitude as the axis. The length or height of the cone is equal to the altitude of the triangle and the radius of the base of the cone is equal to the base of the triangle. The apex angle of the cone is 2θ .

When a cone is cut by a plane, the curve formed along the section is known as a conic section.



Following are some important conic sections.

- 1.Circle
- 2.Ellipse
- 3.Parabola
- 4.Hyperbola

CIRCLE :

When a cone is cut by a section plane A-A making an angle $\alpha = 90^\circ$ with the axis, the section obtained is a circle.

ELLIPSE :

When a cone is cut by a section plane B-B at an angle, α more than half of the apex angle i.e., θ and less than 90° , the curve of the section is an ellipse. Its size depends on the angle α and the distance of the section plane from the apex of the cone.

PARABOLA :

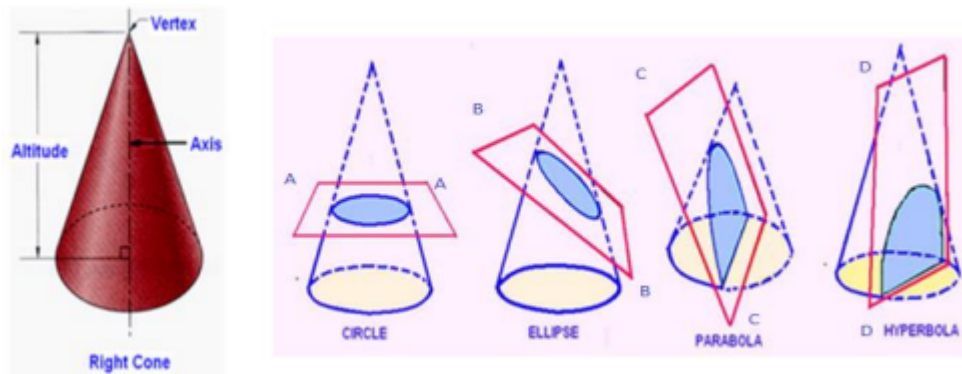
If the angle α is equal to θ i.e. When the section plane C-C is parallel to the slant side of the cone the curve at the section is a parabola. This is not a closed figure like a circle or ellipse. The size of the parabola depends upon the distance of the section plane from the slant side of the cone.

HYPERBOLA:

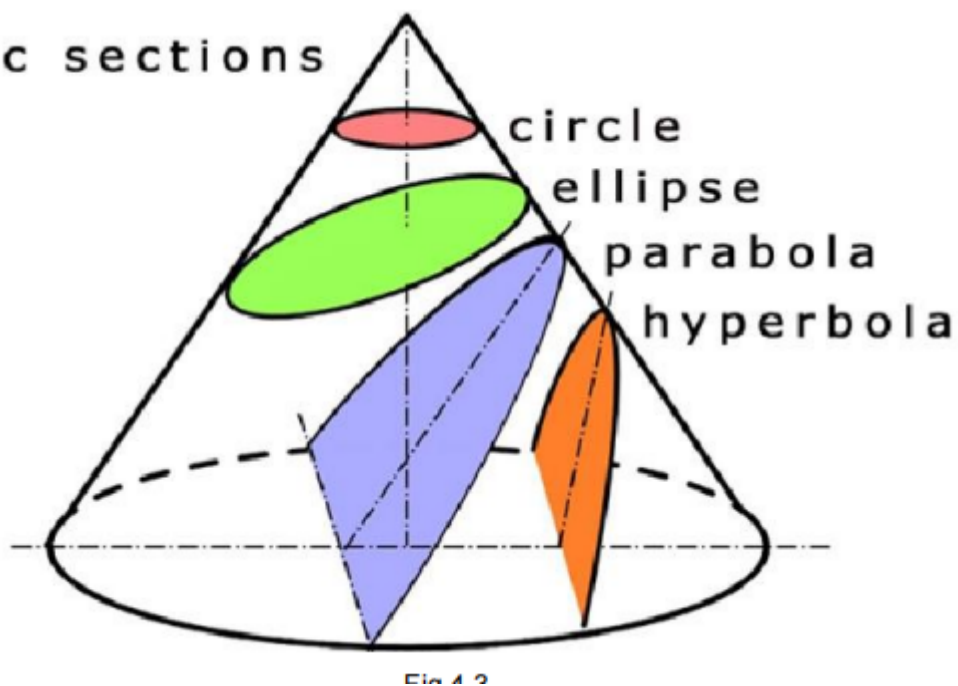
If the angle α is less than θ (section plane D-D), the curve at the section is hyperbola.

The curve of intersection is hyperbola, even if $\alpha = \theta$, provided the section plane is not passing through the apex of the cone. However if the section plane passes through the apex, the

the section produced is an isosceles triangle.



Conic sections



4.2 SOME IMPORTANT DEFINITIONS:

Major axis : It is the longest distance which passes through the centre, at right angle to the fixed lines called the directrix. AB is the major axis.

Minor axis : It is the maximum distance which bisects the major axis at right angles. It will be parallel to the directrix. CD is the minor axis.

Directrix : It is a straight line perpendicular to the major axis.

Focus: When an arc is drawn with C or D as centre and radius equal to half of the major axis

i.e. $AB/2$ it is cut at two points F1 and F2 on the major axis. F1 and F2 are the focal points of an

ellipse F1 or F2 is the focus. The sum of the distances from F1, F2 to any point on the curve i.e.,

$F_1P + F_2P$ is always constant and equal to the major axis.

Focal radii : The distances from point P on the curve to the focal points F1 and F2 are called focal radii. Sum of the focal radii is equal to the major axis.

Eccentricity: The ratio between the distances from the vertex to focus and vertex to the a directrix is called eccentricity.

a.If $e=1$, it is parabola

b.If $e>1$, it is hyperbola

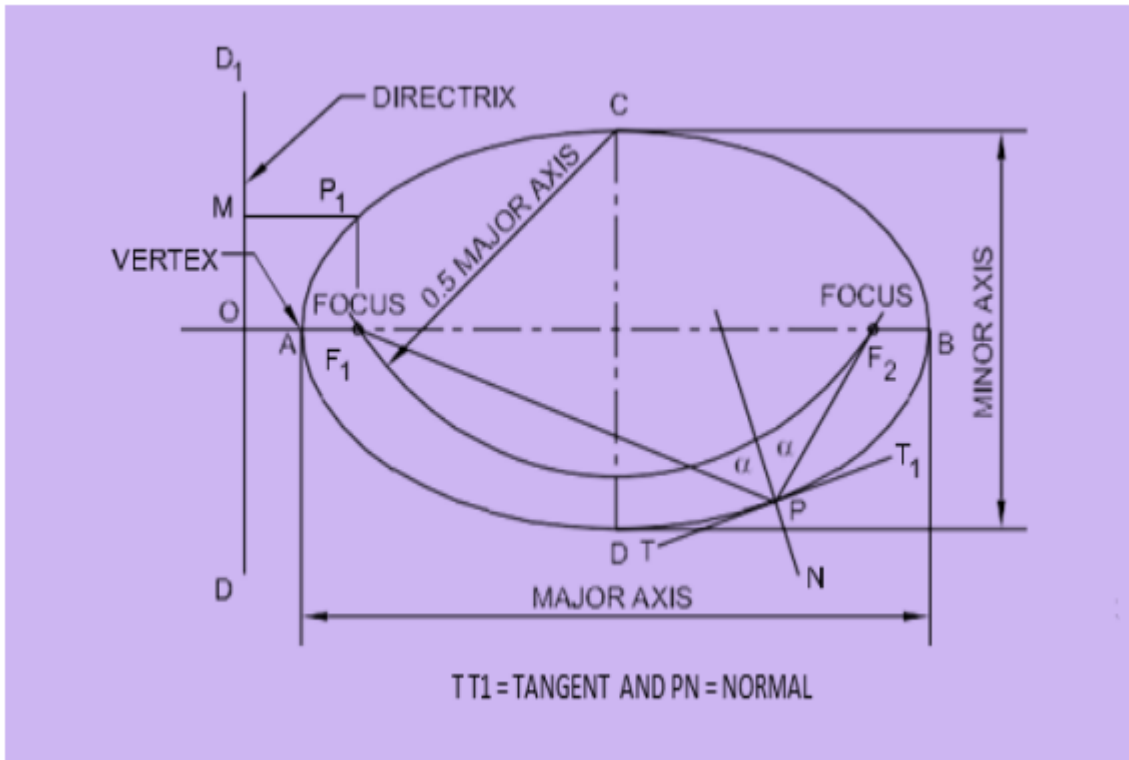
c.If $e<1$, it is an ellipse

Vertex : The end points of the major axis on the curve are called vertex. (A, B)

Tangent and normal to an ellipse : Normal is the line bisecting the angle $F_1 P F_2$ in Fig 4.

Tangent is a line at 90° to the normal and touching the ellipse.

Directrix, axis, focus, vertex and tangent are the elements common to ellipse, parabola and hyperbola.



Q. No. 1.

To draw a parabola with the distance of the focus from the directrix at 60mm (Eccentricity method)

Construction :

Draw the directrix AB and the axis CC'' at right angles to it:

Mark the focus F on the axis at 60 mm.

Locate the vertex V on CC'' such that $CV = VF$

Draw a line VB perpendicular to CC'' such that $VB = VF$

Join C, B and extend. Now, $VF / VC = 1$, the eccentricity.

Locate number of points 1, 2, 3,, on VC'' and erect perpendiculars through them meeting

CB produced at 1',2',3'.....

With F as a centre and radius equal to 1-1'' cut two arcs on the perpendicular through 1 to

locate P1 and P1''. Similarly with F as center and radius 2-2'',

3-3'' etc cut arcs on the

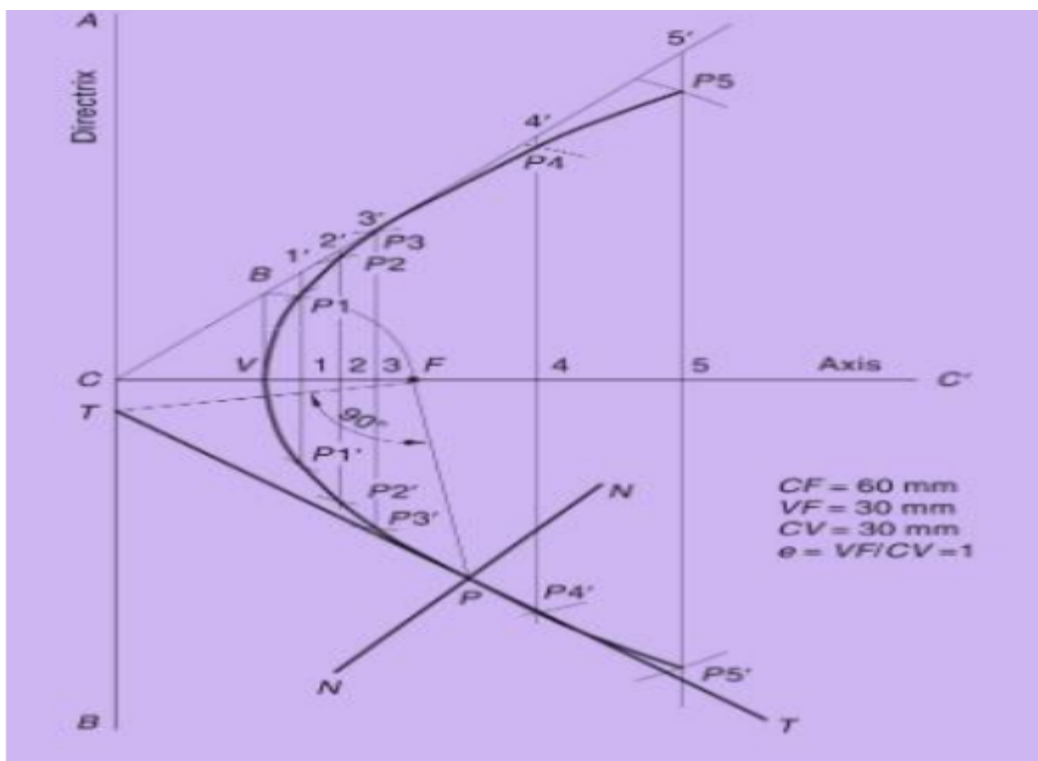
corresponding perpendiculars to locate P2 and P2'', P3 and P3'' etc.

Draw a smooth curve passing through V, P1, P2, P3....P3'', P2'', P1''.

To draw a normal and tangent through a point 40mm from the directrix.

To draw a tangent and normal to the parabola. locate the point P which is at 40 mm from the directrix. Then join P to F and draw a line through F, perpendicular to PF to meet the directrix at T.

The line joining T and P and extended is the tangent and a line NN, through P and perpendicular to TP is the normal to the curve

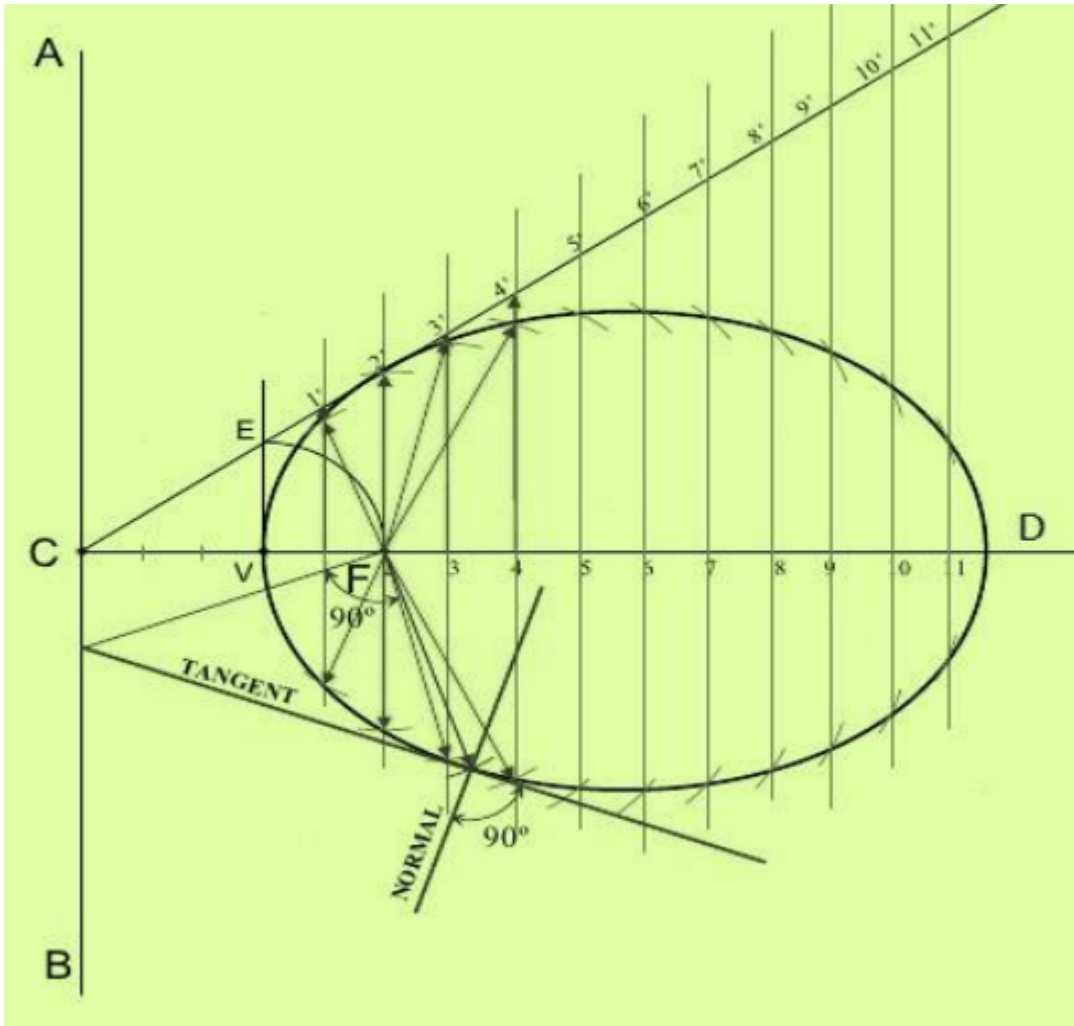


Q. No. 2.

To draw an ellipse with the distance of the focus from the directrix at 50mm and eccentricity = $\frac{2}{3}$
(Eccentricity method).

Construction :

1. Draw any vertical line AB as directrix and mark a point C on it.
2. Draw a horizontal line CD of any length from point C as axis.
3. Mark a point F on line CD at 50mm from C.
4. Divide CF in 5 equal divisions.
5. Mark V on 2nd division from F.
6. Draw a perpendicular on V and mark a point E on it at a distance equal to VF.
7. Join CE and extend it.
8. Mark points 1, 2, 3, ... on CF beyond V at uniform distance and draw perpendiculars on each of them so as to intersect extended CE at 1'', 2'', 3''



Q. No. 3.

To draw a hyperbola with the distance of the focus from the directrix at 50mm and $e=3/2$ (Eccentricity method).

Construction :

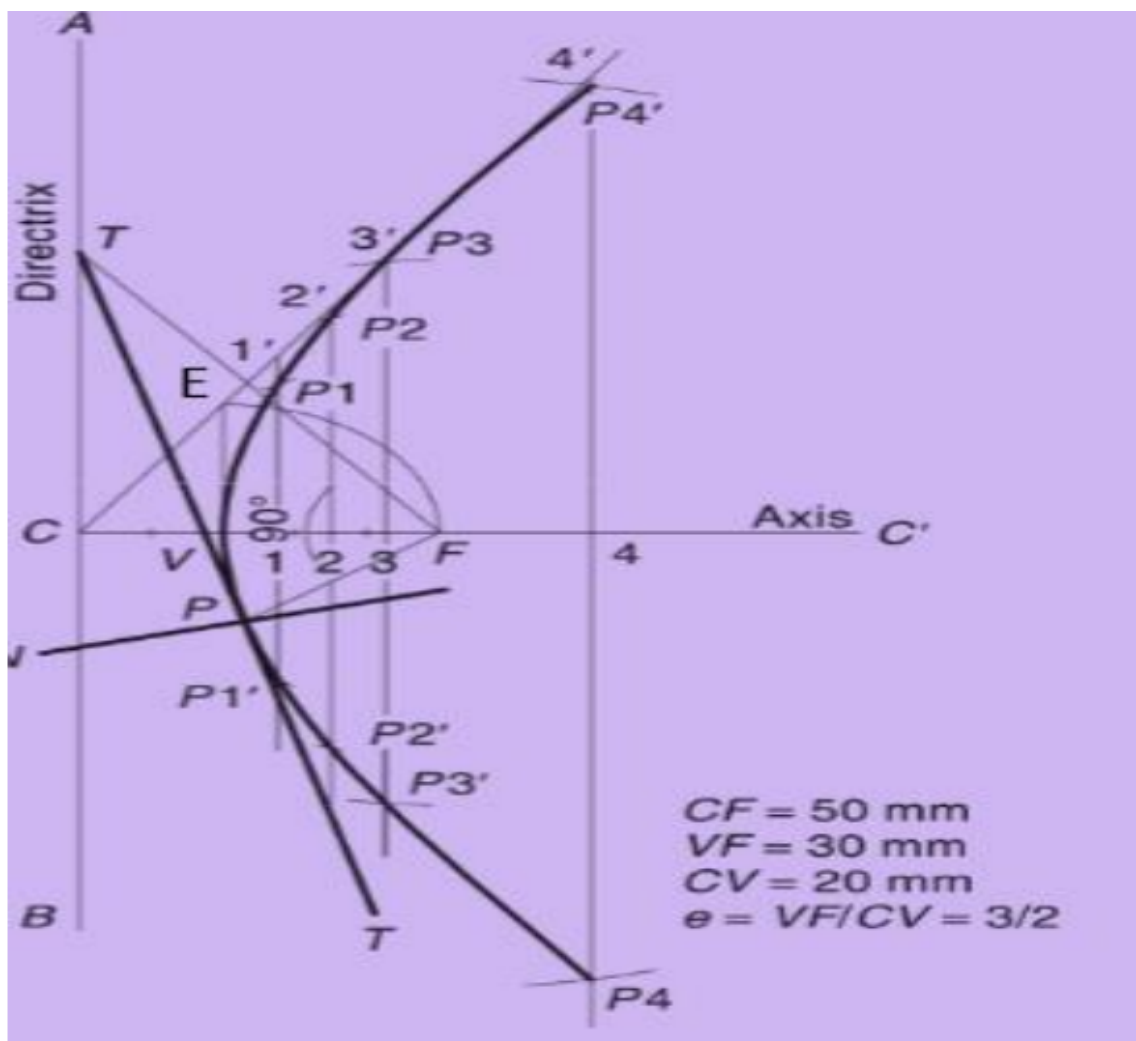
1. Draw the directrix AB and the axis CC''.
2. Mark the focus F on CC'' and 50mm from C.
3. Divide CF into 5 equal divisions and mark V the vertex, on the second division from C.

4. Draw a line BE perpendicular to CC'' such that VE=VF.
Join C and E.

5. Mark any point 1 on the axis and through it, draw a perpendicular to meet CE produced at 1'.

6. With centre F and radius equal to 1-1', draw arcs intersecting the perpendicular through 1 at P1 and P1'.

Similarly mark a number of points 2, 3 etc and obtain points P2 and P2', etc.



Q. No. 5.

The foci of an ellipse are 90 mm apart and its minor axis is 65 mm. Find major axis and construct ellipse by arcs of circle method.

Construction :

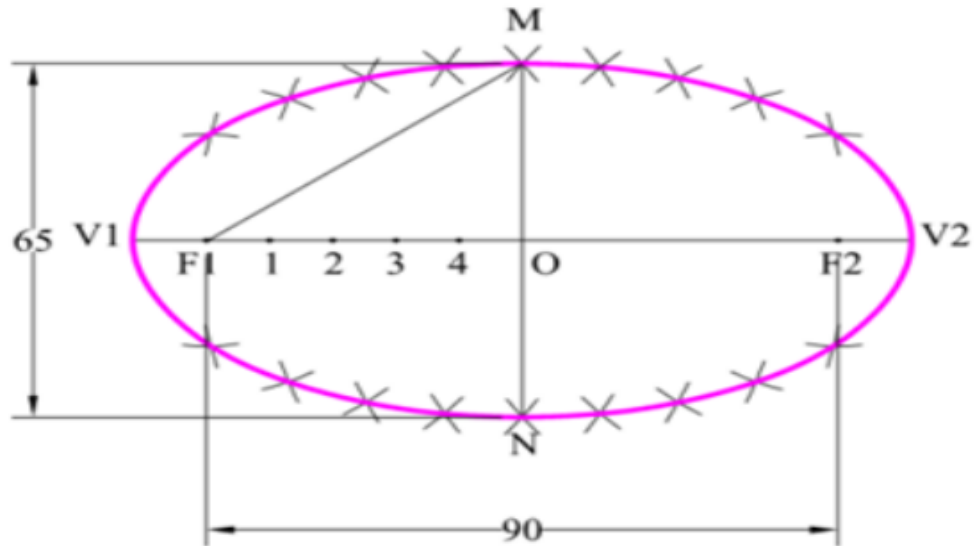


Fig 4.9

All dimensions are in mm

1. Draw a horizontal line. Mark F1 and F2 such that distance between F1 and F2 is 90 mm (Focal distance). Mark midpoint of F1-F2 as 'O'.
2. Draw vertical line through 'O' and mark MN (minor axis = 65mm) such that OM = ON = 32.5 mm.
3. We know MF1 = OV1 = OV2. Take distance in compass equal to MF1 and mark points V1 and V2 by taking center as 'O'. V1-V2 is major axis.
4. Mark 4 to 5 points randomly between F1 and O. Name the points as 1, 2, 3, 4.
5. Take distance in compass equal to V1-1 and by taking center F1 mark arcs above and below the major axis. With same distance and taking center F2 mark arcs above and below the major axis.
6. Take distance in compass equal to V2-1 and by taking center F1 mark arcs to cut previous arcs. With same distance and taking center F2 mark arcs to cut previous arcs.
7. Repeat the procedure for all remaining points 2, 3, 4 and also for 'O'.
8. Draw a smooth curve passing through all points and end of major axis.

Q. No. 6.

Draw a parabolic arc with a span of 1000 mm and a rise of 800 mm. Use the rectangular method.

Construction :

1. Draw an enclosing rectangle ABCD with base AB = 1000 mm and height BC = 800 mm using a suitable scale;
2. At its mid-point E, draw the axis EF at right angle to AB;
3. Divide AE and AD into the same of equal parts and label them, say 1, 2, 3 and 1', 2', 3' etc;
4. Draw lines joining F with points 1, 2 and 3. Through 1', 2', and 3', draw perpendiculars to AE intersecting F1, F2 and F3 at points P₁, P₂ and P₃ respectively;
5. Draw a curve through A, P₁, P₂ etc. It will be a half parabola.

Repeat the same construction in the other half of the rectangle to complete the parabola. Or, locate the points by drawing lines through the points P₁, P₂ etc. parallel to the base and making each of them of equal length on both the sides of EF, e.g. P₁O = O P₁'. AB and EF are called the base and the axis respectively of the parabola. See Fig. given below.

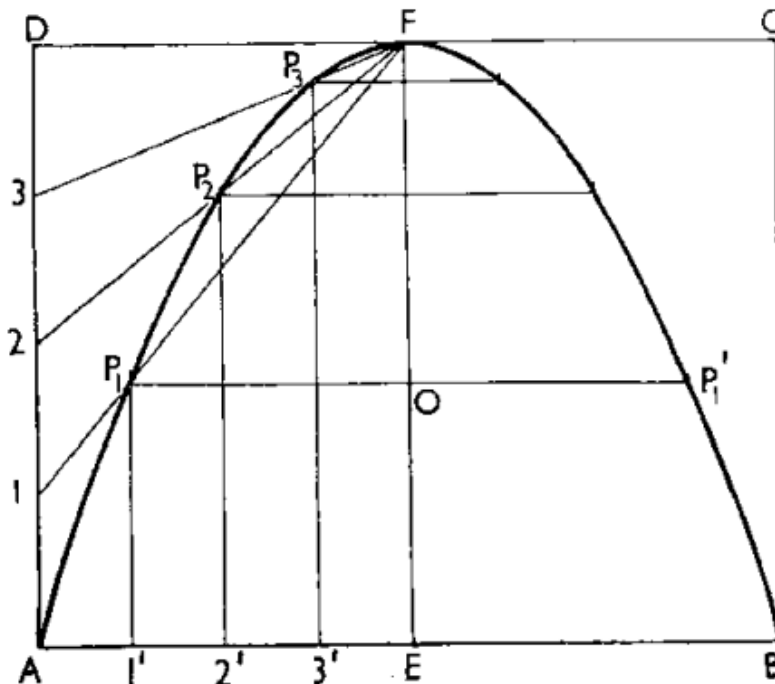


Fig 4.10

All dimensions are in mm

Q. No. 7.

To draw a parabola using the tangent method with 70 mm as base and 30 mm as the length of the axis.

Construction :

1. Draw the base AB and locate its mid-point C.
2. Through C, draw CD perpendicular to AB forming the axis
3. Produce CD to E such that $DE = CD$
4. Join E-A and E-B. These are the tangents to the parabola at A and B.
5. Divide AE and BE into the same number of equal parts and number the points as shown.
6. Join 1-1', 2-2', 3-3', etc., forming the tangents to the required parabola.
7. A smooth curve passing through A, D and B and tangential to the above lines is the required parabola.

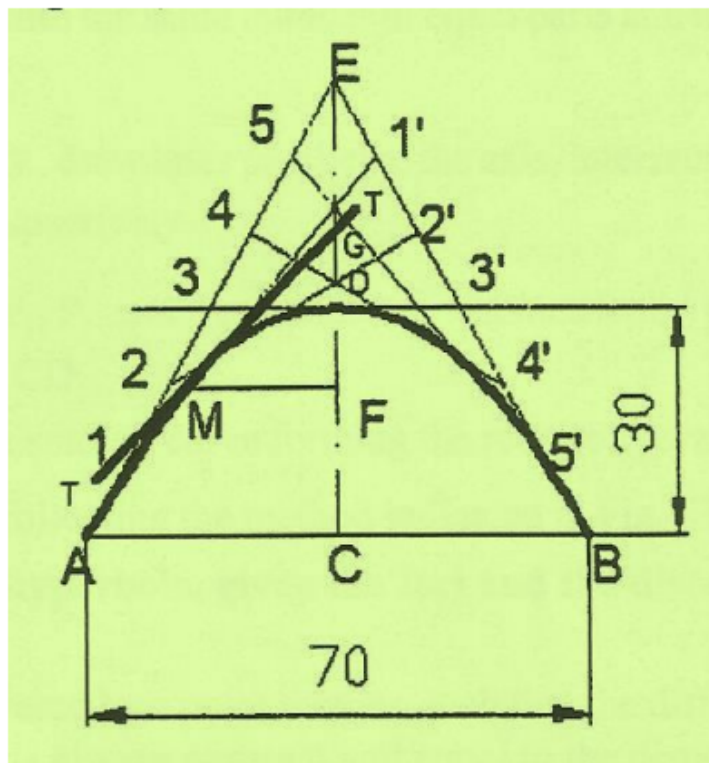


Fig 4.11

All dimensions are in mm

Q. No. 4.

Construct an ellipse by concentric circle method. Major axis 80 mm. Minor axis 40 mm.

Construction :

1. Draw the major axis AB(80mm) and minor axis CD (60mm), bisecting at right angle at O.
2. CD (60mm), bisecting at right angle at O.
3. 'O' as centre OA and OC as radius, draw two concentric circles.
4. Draw a number of radial lines through 'O' (say 12) cutting the two circles.
5. Mark the points on the outer circle as a, b, c.
6. Similarly mark the corresponding intersecting points on inner circle as a', b', c'.
7. From points such as a, b, c...draw lines parallel to minor axis.
8. From points such as a', b', c' draw lines parallel to the major axis to intersect with the corresponding vertical lines at points P₁, P₂, P₃ etc.
9. Join all these points with a smooth curve by free hand or using "French curve" and form the ellipse.

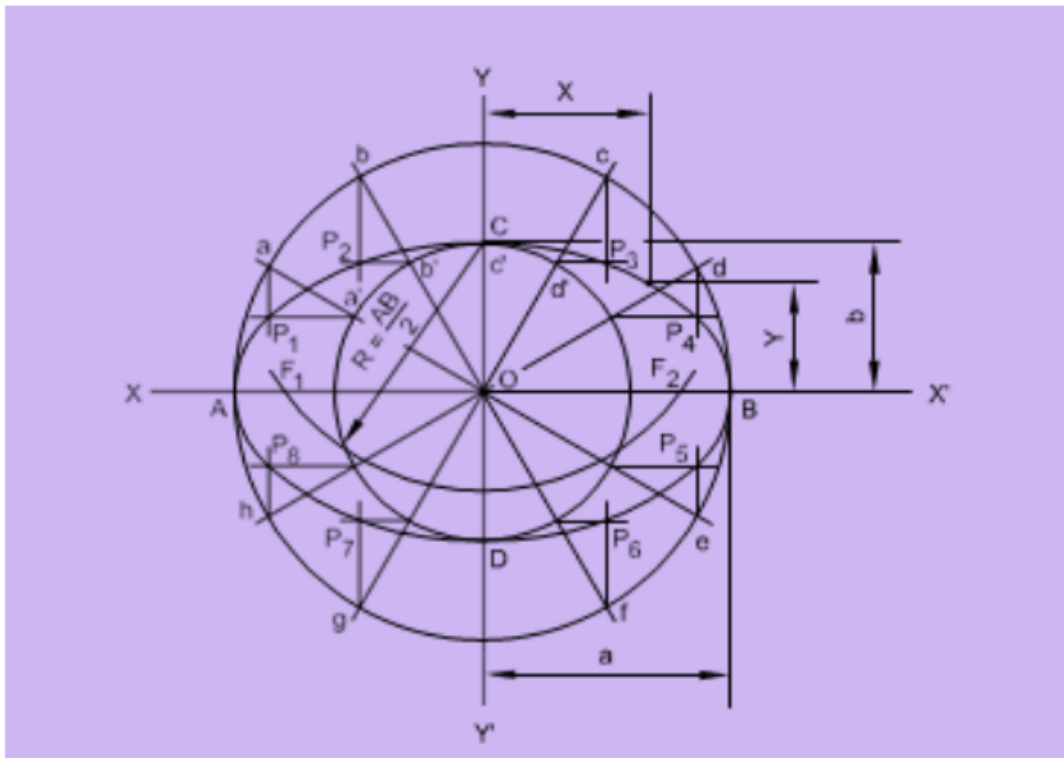


Fig 4.8

CHAPTER 5

ORTHOGRAPHIC PROJECTIONS

5.1 Demonstrate the principles of 1st angle and 3rd angle projections with the help of models and draw symbols.

5.2 Draw projection of points.

5.3 Draw projection of straight line (parallel to both planes, parallel to one and perpendicular to other, parallel to one and inclined to other and inclined to both reference planes).

5.4 Draw plane figures such as squares, rectangles, triangles, circle, Pentagon and hexagon (perpendicular to one plane and inclined to another).

5.5 Draw projections of solids such as prism, cylinder, cone, tetrahedron and pyramid in simple position (with axis parallel to one reference plane and perpendicular to other reference plane).

5.1 Demonstrate the principles of 1st angle and 3rd angle projections with the help of models and draw symbols.

INTRODUCTION

A projection may be defined as a representation of an object on a two dimensional plane. It is obtained by drawing straight lines from various points on the contour of an object that is said to be projected on that plane. The figure formed by joining in the correct sequence, the points at which these lines meet a plane is called the projection of the object. The lines which are drawn from the object to the plane are called projectors. Following are the elements to be considered while obtaining a projection.

- a.Object
- b.Plane of projection
- c.Point of sight
- d.Rays of sight

TYPES OF PROJECTION

Following are the methods of projection commonly used in engineering practice.

- a.Orthographic projection
- b.Isometric projection
- c.Oblique projection
- d.Perspective projection

ORTHOGRAPHIC PROJECTION

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.

DEFINITION OF SOME TERMS IN ORTHOGRAPHIC PROJECTION

i. **Horizontal Plane (H.P)** : It is the plane which is horizontal and at right angle to the vertical plane. The top view or plan of the object is projected on this plane. It is generally denoted in short form as H.P.

ii. **Vertical plane (V.P)**: It is the plane which is perpendicular to the horizontal plane and is also known as frontal plane because the front view or elevation of the object is projected on this plane. It is generally denoted by V.P. The V.P and H.P. are called principal planes.

iii. **Auxiliary plane (A.P)** : Any other plane which is placed at any angles to the principal plane i.e. H.P. and V.P. are called auxiliary planes.

iv. **Reference line**: The line of intersection of two principal planes of projection i.e. V.P and H.P. is called a reference or ground or intersection line. It is generally denoted by the X-Y line.

v. **Elevation** : The projection of the object on the vertical plane (V.P) is called elevation or Front View (F.V). Front View of the object is taken while looking at the object from its front.

vi. **Plan** : Plan or top view (T.V) of the object is taken while looking at the object from its top.

The plan or top view is projected on the horizontal Plane (H.P).

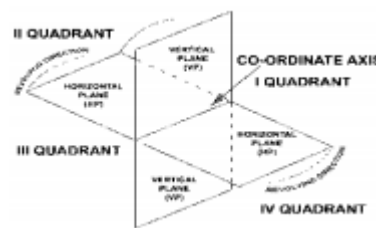
vii. **Side view or End View** : Projection of the object on an auxiliary plane (A.P) or auxiliary

A vertical plane (AVP) is known as a side view or end view or profile view or side elevation.

viii. **Auxiliary View** : The projection of the object on an auxiliary plane is known as auxiliary view (A.V).

FOUR QUADRANTS

The object may be situated in any of the four quadrants , its position relative to the planes being described as above or below the H.P and in front of or behind the V.P. In INDIA generally the first angle projection is adopted for drawing works but in countries like U.S.A, Canada, U.K etc third angle projection is adopted for normal drawing work .



Object placed in 1st Quadrant: Above H.P and in front of V.P.

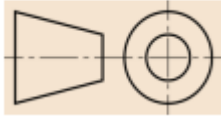
Object placed in 2 nd Quadrant: Above H.P and behind V.P.

Object placed in 3rd Quadrant: Below H.P and behind V.P.

Object placed in 4 th Quadrant : Below H.P and in front of V.P.

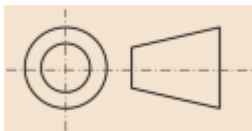
FIRST ANGLE PROJECTION :

If the object is situated in the first quadrant i.e above H.P and in front of V.P. , the projection of the object so obtained is known as First Angle projection



THIRD ANGLE PROJECTION :

If the object is situated in the third quadrant i.e below H.P and in behind V.P. The projection of the object so obtained is known as third Angle projection,



PROJECTION OF POINTS :

INTRODUCTION

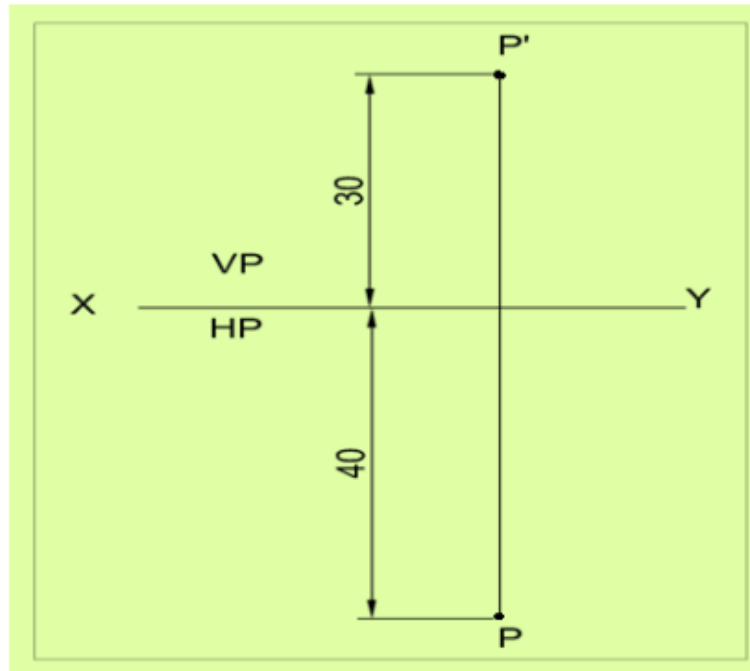
A point may be defined as a line having zero length or it also may be defined as a circle having zero diameter. It has no size and dimensions.

Q. No. 1.

Draw the orthographic projections of the Point P which is 30 mm above H.P and 40 mm in front of V.P.

Solution :

- i. As the point is above H.P. and in front of V.P.; so it is in 1st quadrant.
- ii. Draw a line XY (Reference Line) which is the intersection line of HP and VP.
- iii. As 'P' is 30mm above H.P.', its front view 'p'' is 30 mm XY.
- iv. 'P' is 40 mm in front of VP , its top view 'p' is 40 mm from XY.
- v. Draw the projector pp' as shown in figure.

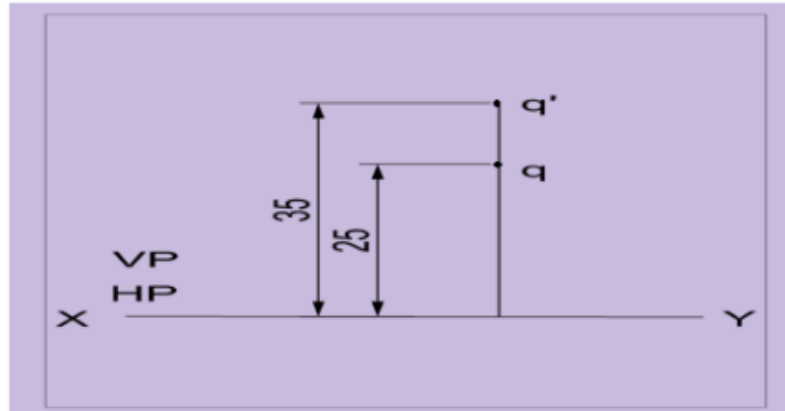


Q. No. 2.

Draw the orthographic projections of the Point Q which is 25 mm above H.P and 35 mm behind VP

Solution :

- i. As the point is above H.P. and behind V.P.; so it is in 2nd quadrant.
- ii. Here both the views (top and front) will be obtained above the reference line XY, Hence the H.P will coincide with V.P.
- iii. Draw a reference line XY. Mark a point 'q' 25mm above XY which is the front view and another point 'q' 35mm from XY which is the top view as shown in figure.

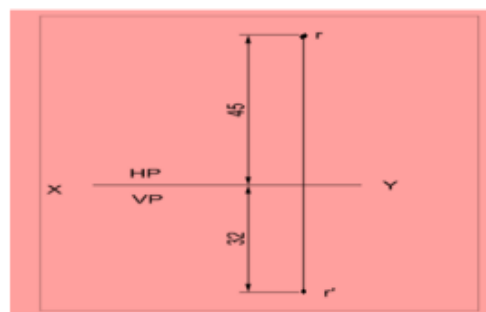


Q. No. 3.

Draw the orthographic projections of the Point R is 32 mm. below H.P and 45 mm behind VP

Solution :

- i. As the point is below H.P. and behind V.P.; so it is in 3rd quadrant.
- ii. Here the front and top view will be obtained on VP and HP assuming VP is transparent.
- iii. Draw the reference line XY. Mark the front view at a distance 32 mm below XY and top view at a distance 45 mm above XY as shown.



Q. No. 4.

Draw the orthographic projections of the Point S is 35 mm. below H.P and 42 mm in front of VP

Solution :

- i. As the point is below H.P. and in front of V.P.; so it is in 4th quadrant.
- ii. Here both the views will be lie below the reference line as the H.P. coincides with V.P as shown.
- iii. Draw the reference line XY. Mark the front view and top view at a distance of 20mm and 30 mm respectively from XY on the same projector.

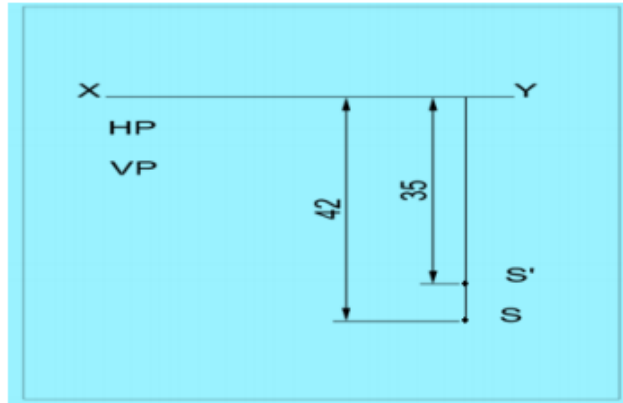


Fig 5.7
All dimensions are in mm

Q. No. 5.

Draw the orthographic projections of the Point T is in H.P and 30 mm behind VP

Solution :

- i. As the point is in H.P. and behind V.P.; so it is in H.P.
- ii. Here side view will be on VP and top view 30mm behind VP.
- iii. Draw the reference line XY. Mark the front view at any point on XY and top view at a distance of 30 mm from XY on the same projector.

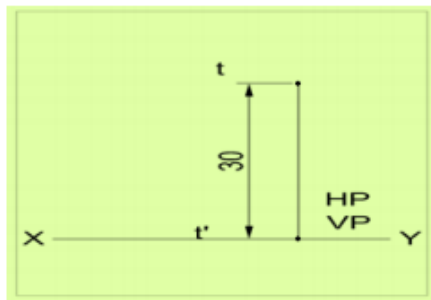


Fig 5.8

Q.No. 6.

Draw the orthographic projections of the Point U is in V.P and 40 mm. below HP

Solution :

- i. As the point is in V.P. and below H.P.; so it is in V.P.
- ii. Here side view will be on VP and top view 40 mm. below HP.
- iii. Draw the reference line XY. Mark the top view at any point on XY and side view at a distance of 40 mm from XY on the same projector.

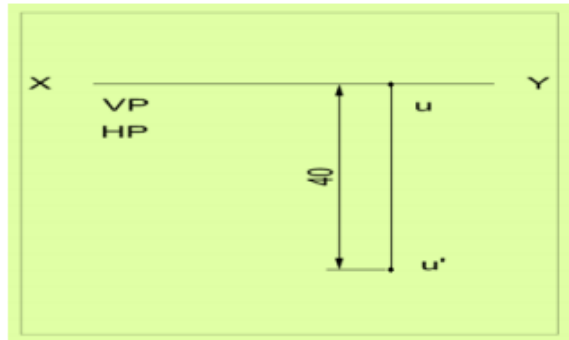


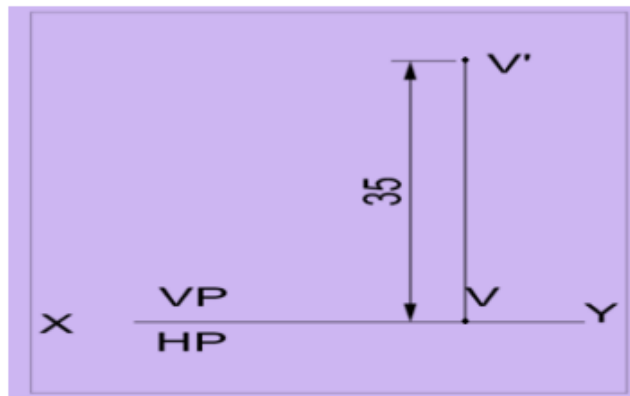
Fig 5.9
All dimensions are in mm

Q. No. 7.

Draw the orthographic projections of the Point V is in V.P and 35 mm. above H.P

Solution :

- i. As the point is in V.P. and above H.P.; so it is in V.P.
- ii. Here side view will be on VP and top view on HP.
- iii. Draw the reference line XY. Mark the top view at any point on XY and side view at a distance of 35 mm from XY as shown in fig 5.10.

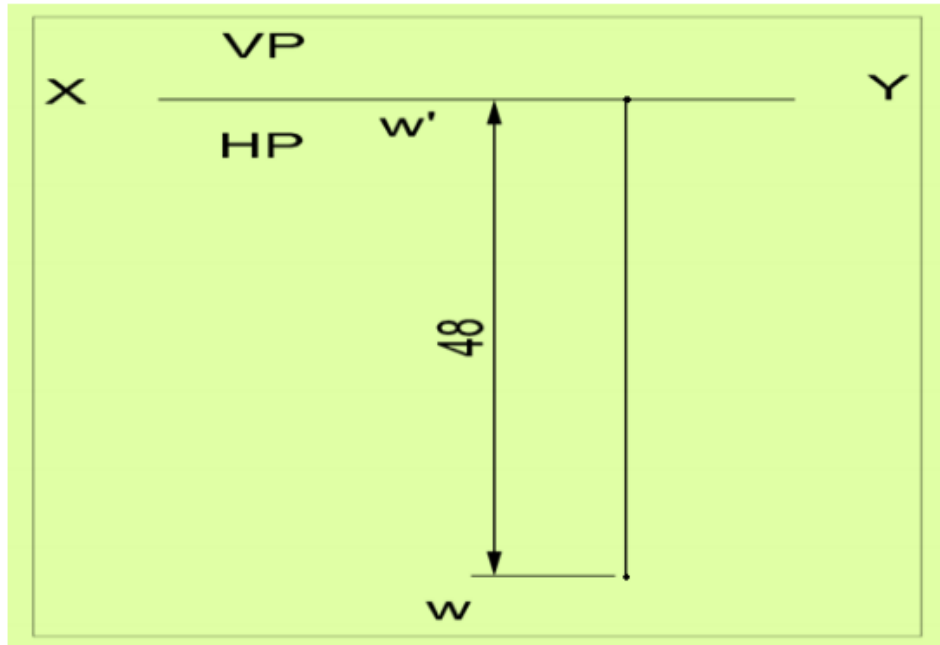


Q. No. 8.

Draw the orthographic projections of the Point W is in H.P and 48 mm. in front of VP

Solution :

- i. As the point is in H.P. and 48mm in front of V.P.; so it is in H.P.
- ii. Here side view will be on VP and top view on HP.
- iii. Draw the reference line XY. Mark the side view at any point on XY and top view at a distance of 48 mm from XY as shown in fig 5.11.



5.3 PROJECTION OF LINES :

5.3.1 INTRODUCTION

A straight line may be defined as the shortest distance between any two points. It may be generated by a point moving in one direction.

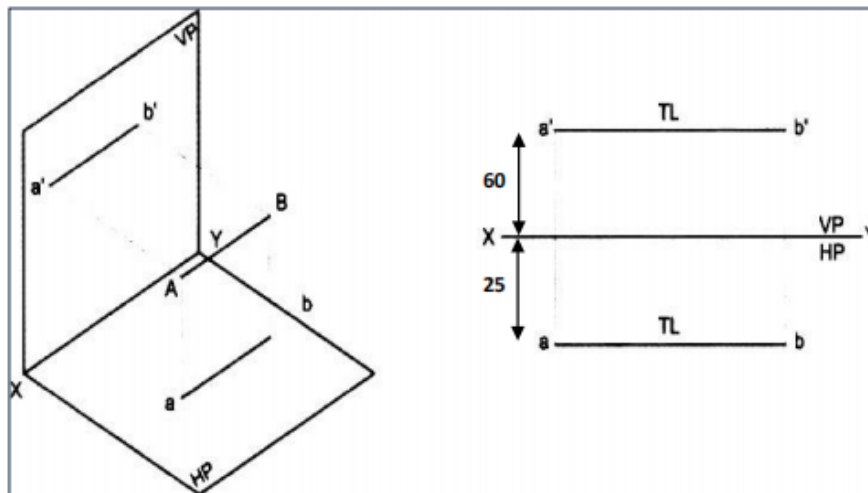
5.3.2 SOLVED PROBLEMS

Q. No. 1.

A 50mm long line AB is parallel to both H.P and V.P. The line is 25mm in front of V.P and 60mm above H.P, draw the projections of the line.

Solution :

- i. Draw reference axis XY.
- ii. Mark the side view of the point A of the line AB i.e a' at a distance of 60mm above XY and "a" 25mm below XY.
- iii. Through a' and a draw lines a'b' and ab parallel to XY of its true length 50mm.
- iv. a'b' and ab are the front view and top view of line AB respectively.



Q. No. 2.

A 60mm long line AB has its end A at a distance of 20mm above the H.P. The line is perpendicular to the H.P and 40mm in front of V.P, draw the projections of the line.

Solution :

- i. Draw reference axis XY.
- ii. Mark the side view of the point A of the line AB i.e a' at a distance of 20mm above XY and top view "a" at 40 mm below XY.
- iii. Through a' and a draw lines a'b' of its true length 60mm. Point "a" will coincide with point "b" in its top view.
- iv. a'b' and (a)b are the front view and top view of line AB respectively. Since point "a" is hidden, it is represented in brackets.

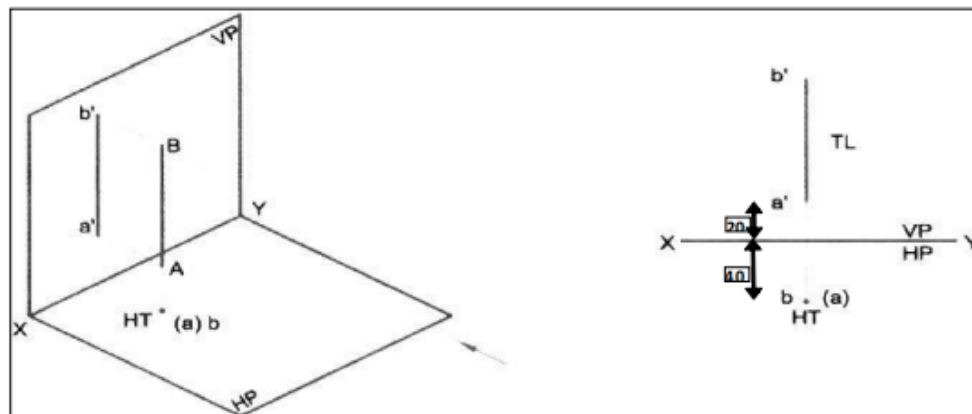


Fig 5.13

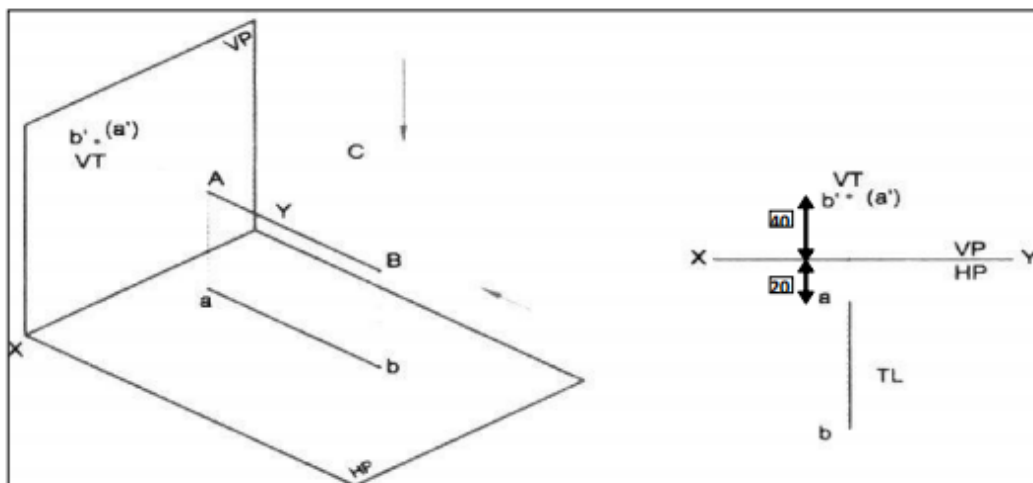
All dimensions are in mm

Q. No. 3.

A 60mm long line AB, has its end A at a distance of 20mm in front of the V.P. the line is perpendicular to V.P and 40mm above H.P, draw the projection of the line.

Solution :

- i. Draw reference axis XY.
- ii. Mark the side view of the point B of the line AB i.e b' at a distance of 40mm above XY and top view "a" at 20mm below XY.
- iii. Through "a" draw line ab of its true length 60mm in the direction perpendicular to XY. Point a' will coincide with point b' in its side view.
- iv. (a')b' and ab are the front view and top view of line AB respectively. Since point a' is hidden, it is represented in brackets.



5.4 PROJECTION OF PLANES:

5.4.1 INTRODUCTION

A plane is a two-dimensional object having length and breadth only. Its thickness is always neglected; various shapes of plane figures are considered such as square, rectangle, circle, pentagon, hexagon etc.

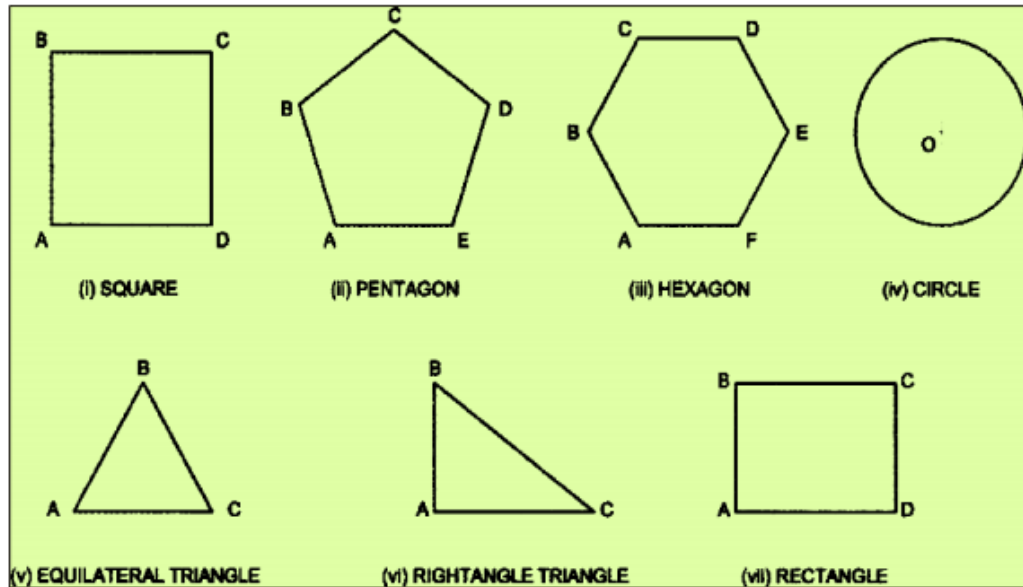


Fig 5.18

5.4.2 TYPES OF PLANES :

1. Perpendicular planes which have their surface perpendicular to any one of the reference planes and parallel or inclined to the other reference plane.
2. Oblique planes which have their surface inclined to both the reference planes.

5.4.3 TRACE OF PLANE :

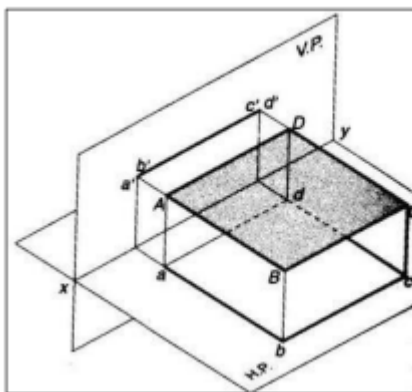
The trace of a plane is the line of intersection or meeting of the plane surface with the reference plane; if necessary the plane surface is extended to intersect the reference plane. The intersection line of the plane surface with **HP** is called the **Horizontal Trace (HT)** and that of **VP** is called the **Vertical Trace (VT)**.

A plane figure is positioned with reference to the reference planes by referring its surface in the following possible position.

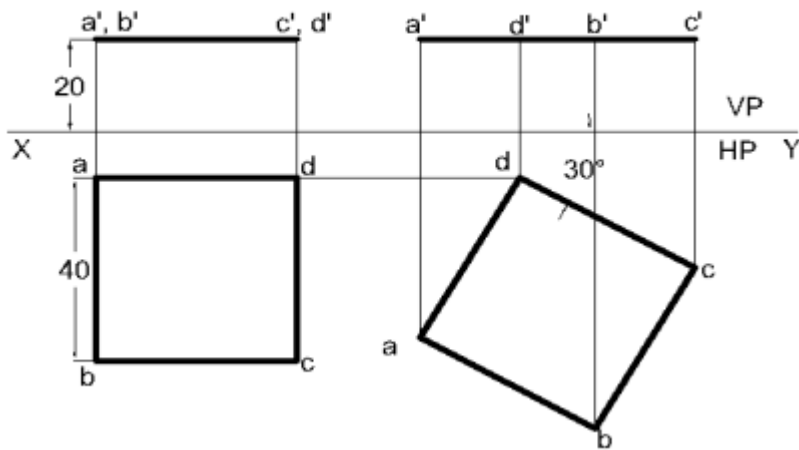
Q. No. 1 : A Square plane with a 40mm side has its surface parallel to and 20mm above the HP. Draw its Projections, when (a) A side is parallel to VP (b) A side is inclined at 30° to VP

Solution :

Visualized position of surface plane Picture:

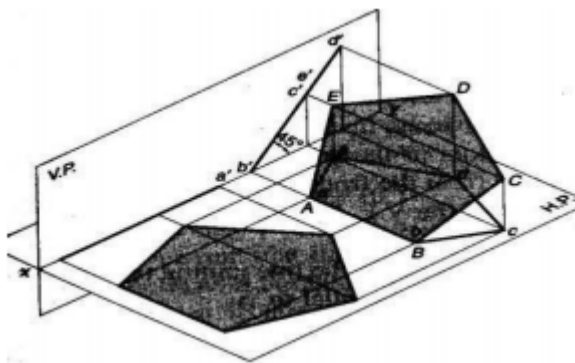


- i. Draw a square $abcd$ of side 40mm such that one of its sides say ad is parallel to XY .
- ii. Draw projectors from the points a & d .
- iii. Locate the points $a''b''$ at 20mm above XY .
- iv. Draw a line through a'' and parallel to XY intercepting the projector through d at $c''d''$. $a''b''c''d''$ & $abcd$ are the required projections.
- v. Similarly draw the projection of the point $abcd$ when two of its sides are inclined at 30° to VP.



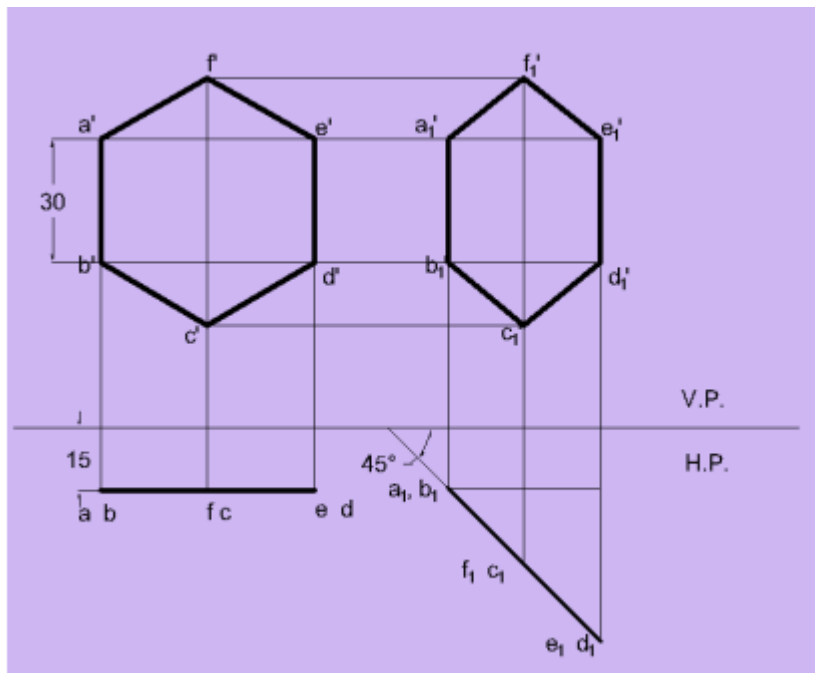
Q. No. 2. A Hexagonal plane with a 30mm side has an edge on the HP, the surface of the Plane is inclined at 45° to the HP. Draw it's Projections.

Solution : Visualized position of surface plane Picture:



- i. Draw the reference axis XY and then draw the regular hexagon $a''b''c''d''e''f''$ in elevation such that one of its sides $a''b''$ is perpendicular to the reference axis.
- ii. Draw the top view $abcdef$ below XY and parallel to it.
- iii. Draw the plan in changed position $a_1(b_1)$ f_1 (c_1) e_1 (d_1) so that it makes 45° with XY line and has the point a_1 15mm away from XY.

iv. Complete the corresponding new elevation $a_1''b_1''c_1''d_1''e_1''f_1''$ by projecting from this plane and projecting horizontally from the previous elevation.



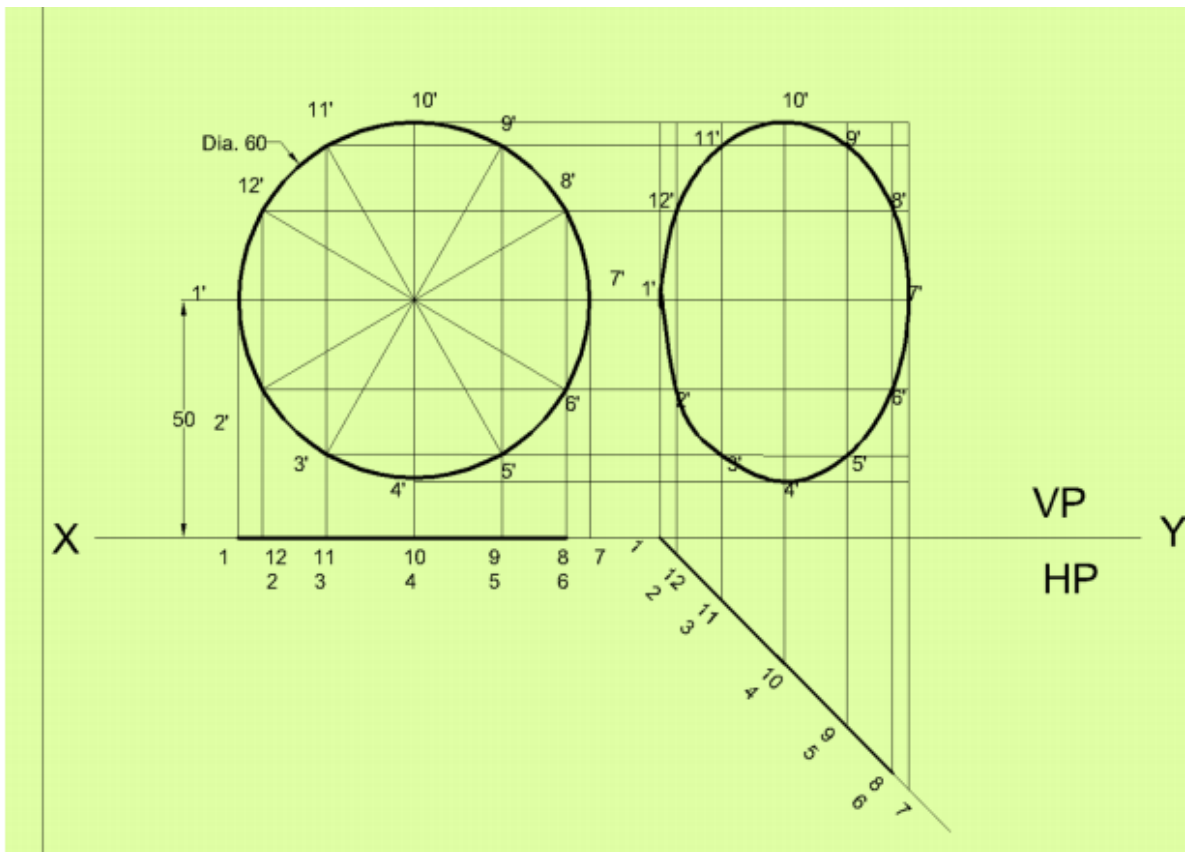
Q. No. 3. A Circular plane with a 60mm Diameter is resting on a point it's circumference on the VP. The center is 50 mm above the HP , and The surface is inclined at 45° to the VP.

And perpendicular to the HP

Draw It's Projections.

Solution :

- i. Draw the projection of the circle assuming it to be lying on VP and it's centre is 50mm above HP.
- ii. Divide the circumference of the circle into 12 equal parts and name them as shown and transfer the division points on the top view.
- iii. Redraw the Top view such that it makes an angle of 45° with XY and one end of it lies on XY forming the final Top view.
- iv. Obtain the final front view by projection.



o. 4. A regular pentagon ABCDE, of 25 mm side has its side BC on ground. Its plane is perpendicular to H.P and inclined at 45° to the V.P. Draw the projections of the pentagon and show its traces when its corner nearest to VP is 15 mm from it.

Solution :

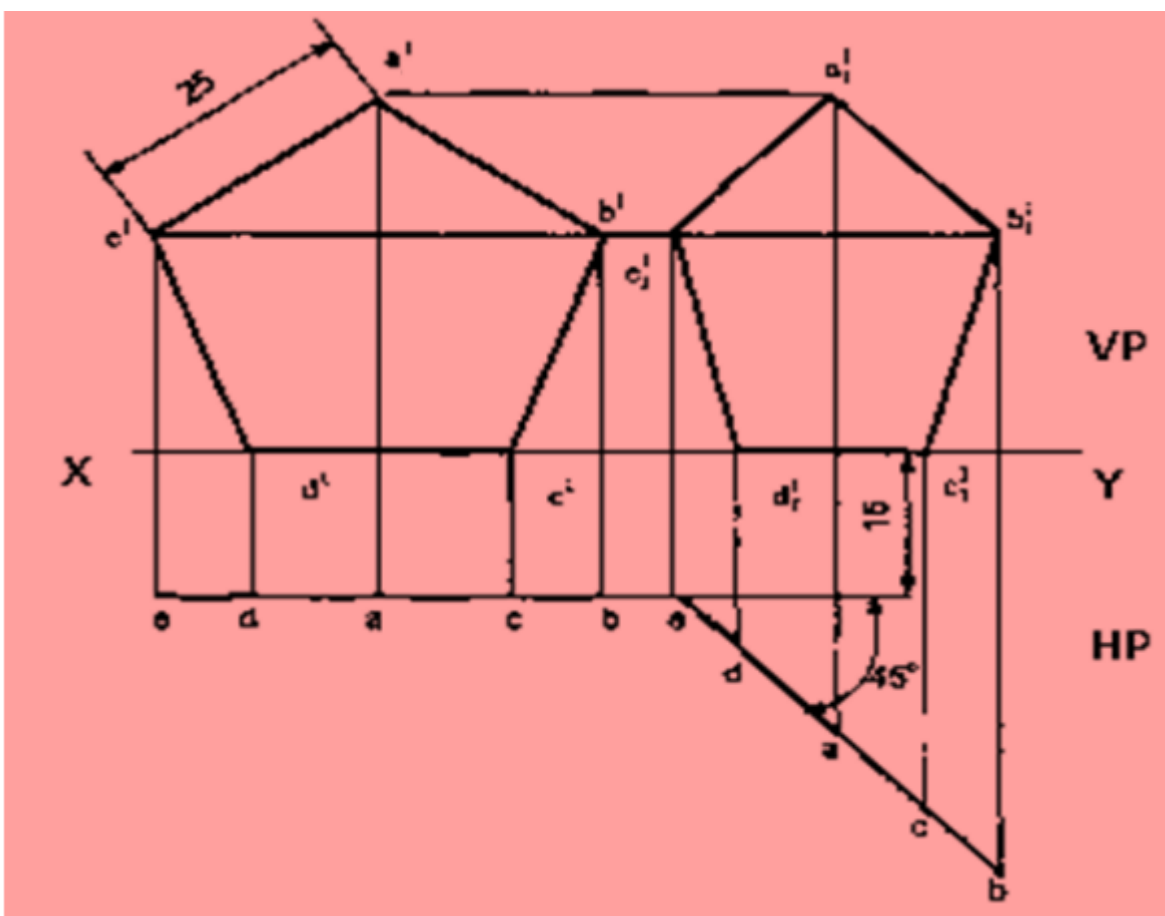
i. As the plane makes an angle 45° to VP, so let's assume that the plane parallel to VP with one of its side say $d''c''$ on HP.

ii. The true shape of pentagon having side 25mm will be seen in the front view with one side on HP. $a''b''c''d''e''$ the required pentagon.

iii. The top view of the pentagon will be a line. Project the points. Draw the line at a distance 15mm from XY below it.

iv. Shift the top view eb to e_1b_1 of equal length making at an angle of 45° to VP as shown.

v. Project the final front view $a_1''b_1''c_1''d_1''e_1''$ as shown.



5.5 PROJECTION OF SOLIDS

INTRODUCTION :

A solid has three dimensions, the length, breadth and thickness or height. A solid may be represented by orthographic views, the number of which depends on the type of solid and its orientation with respect to the planes of projection. Solids are classified into two major groups.

i. Polyhedral

ii. Solids of revolution

Polyhedral

A polyhedral is defined as a solid bounded by plane surfaces called faces. They are:

a. Regular polyhedral

b. Prisms

c. Pyramids

Regular Polyhedral

A polyhedron is said to be regular if its surfaces are regular polygons. The following are some of the regular polyhedral.

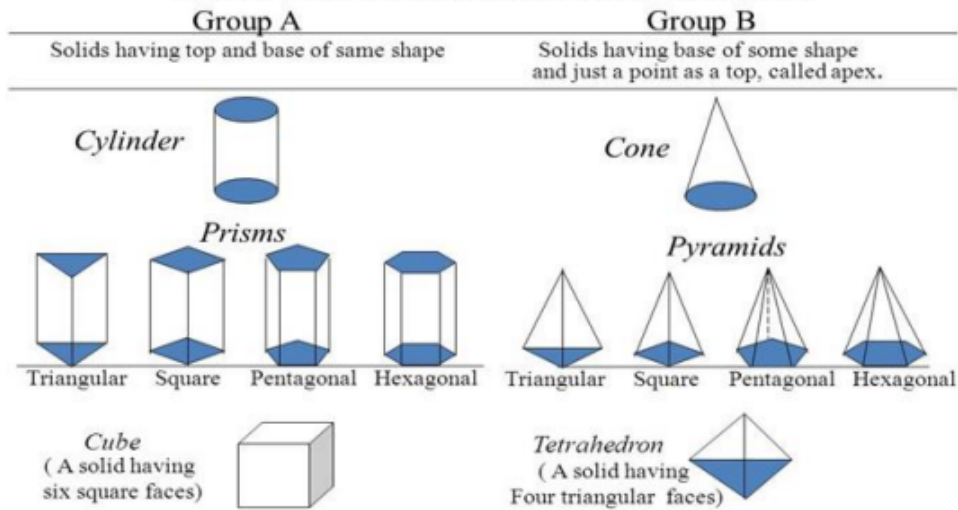
SOLIDS

Prisms : A prism is a polyhedron having two equal ends called the bases parallel to each other. The two bases are joined by faces, which are rectangular in shape. The imaginary line passing through the center of the bases is called the axis of the prism.

A prism is named after the shape of its base. For example, a prism with square base is called a square prism, the one with a pentagonal base is called a pentagonal prism, and so on.

SOLIDS

To understand and remember various solids in this subject properly, those are classified & arranged in to two major groups.



- Tetrahedron:** It consists of four equal faces, each one being an equilateral triangle.
- Hexahedron (cube):** It consists of six equal faces, each as square.
- Octahedron:** It has eight equal faces, each an equilateral triangle.
- Dodecahedron:** It has twelve regular and equal pentagonal faces.
- Icosahedrons:** It has twenty equal, equilateral triangular faces.

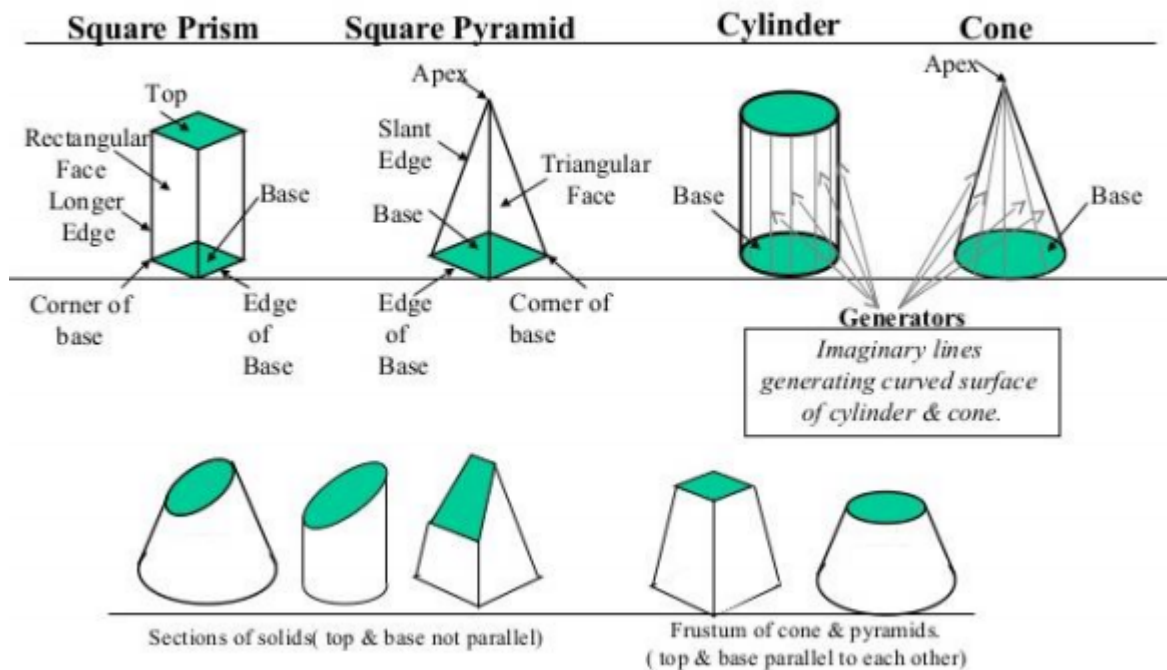
Pyramids :

A pyramid is a polyhedron having one base, with a number of isosceles triangular faces, meeting at a point called the apex. The imaginary line passing through the centre of the base and the apex is called the axis of the pyramid.

The pyramid is named after the shape of the base. Thus, a square pyramid has a square base and pentagonal pyramid has pentagonal base and so on.

SOLIDS

Dimensional parameters of different solids.



of Pyramids :

Types of Pyramids :

There are many types of Pyramids, and they are named after the shape of their base. These are Triangular Pyramid, Square Pyramid, Pentagonal pyramid, hexagonal pyramid and tetrahedron.

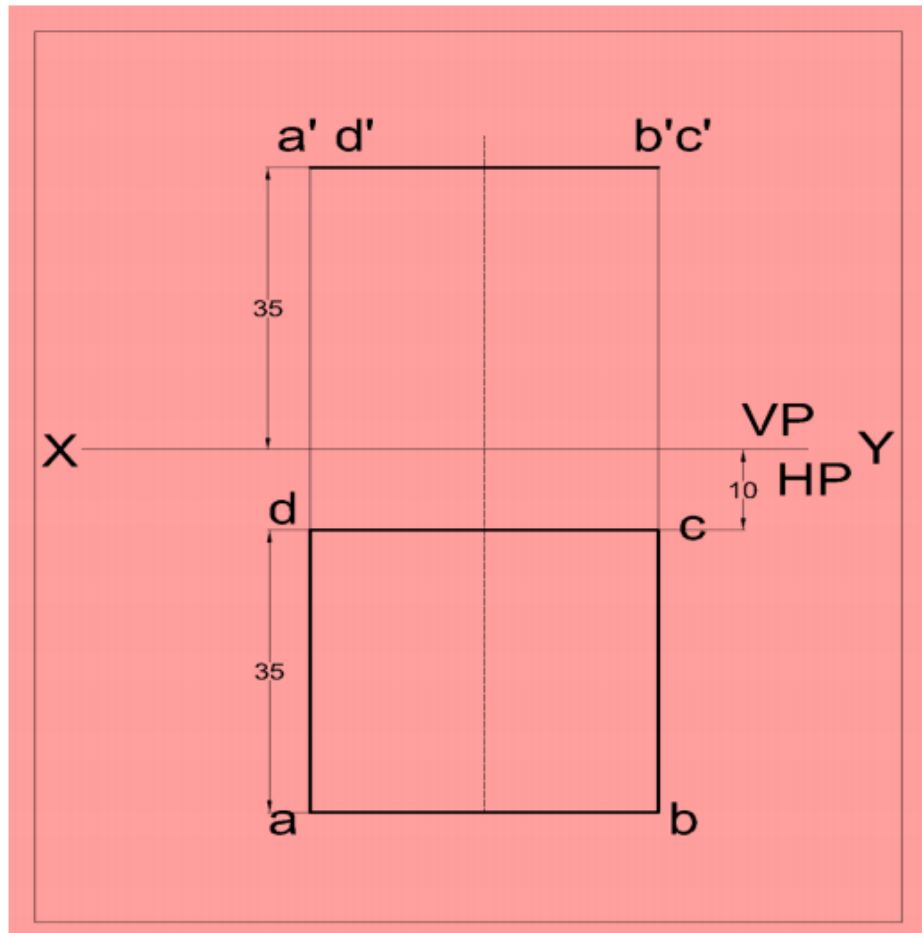
Solids of Revolution : If a plane surface is revolved about one of its edges, the solid generated is called a solid of revolution. The examples are (i) Cylinder, (ii) Cone, (iii) Sphere.

Frustums and Truncated Solids : If a cone or pyramid is cut by a section plane parallel to its base and the portion containing the apex or vertex is removed, the remaining portion is called frustum of a cone or pyramid.

Q. No 1. Draw the projections of a cube of 35mm side, resting on one of its faces (bases) on HP., such that one of its vertical faces is parallel to and 10mm in front of VP.

Solution :

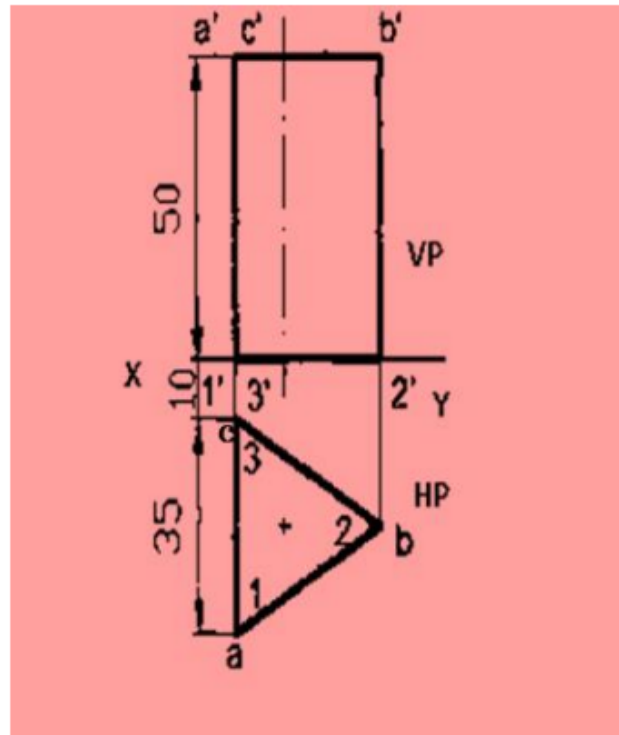
1. Draw the top view such that one of its edges is 10mm below XY.
2. Obtain the front view by projection, keeping one of its bases on XY.



Q. No. 2. A triangular prism with side of base 35mm and axis 50mm long is resting on its base on HF. Draw the projections of the prism when one of its rectangular faces is perpendicular to VP and the nearest edge parallel to VP is 10mm from it.

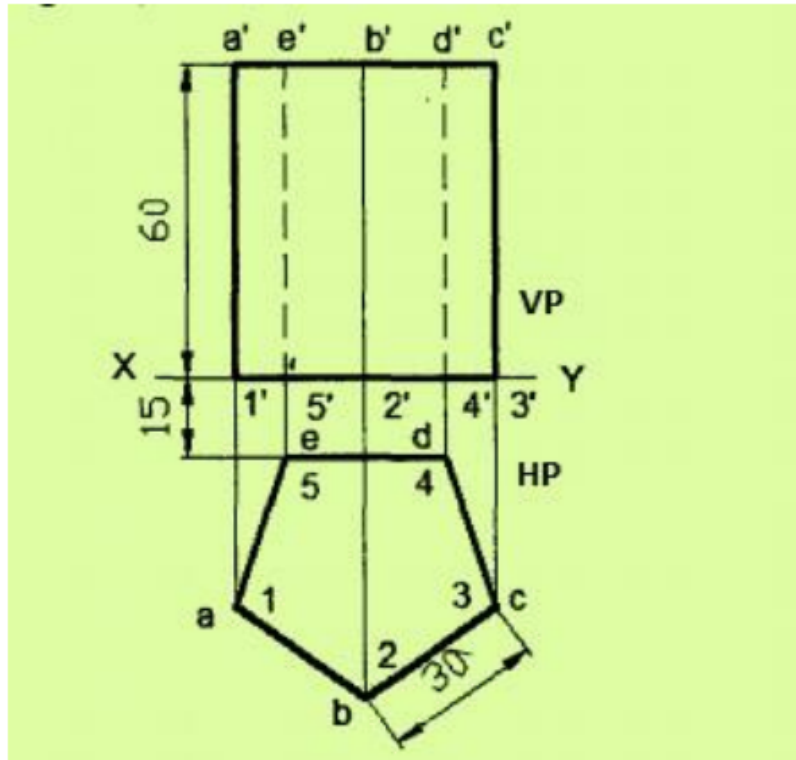
Solution :

Draw the top view keeping one edge perpendicular to XY and one corner at 10mm from XY. Obtain the front view by projection, keeping the height equal to 50mm.



Q. No. 3. A pentagonal prism with side of base 30mm and axis 60mm long is resting on its base on HP such that one of its rectangular faces is parallel to VP and 15mm away from it. Draw the projections of the prism.

1. Draw the top view keeping one edge of the base parallel to XY and 15mm away from it.
2. Obtain the front view by projection keeping the height equal to 60mm.

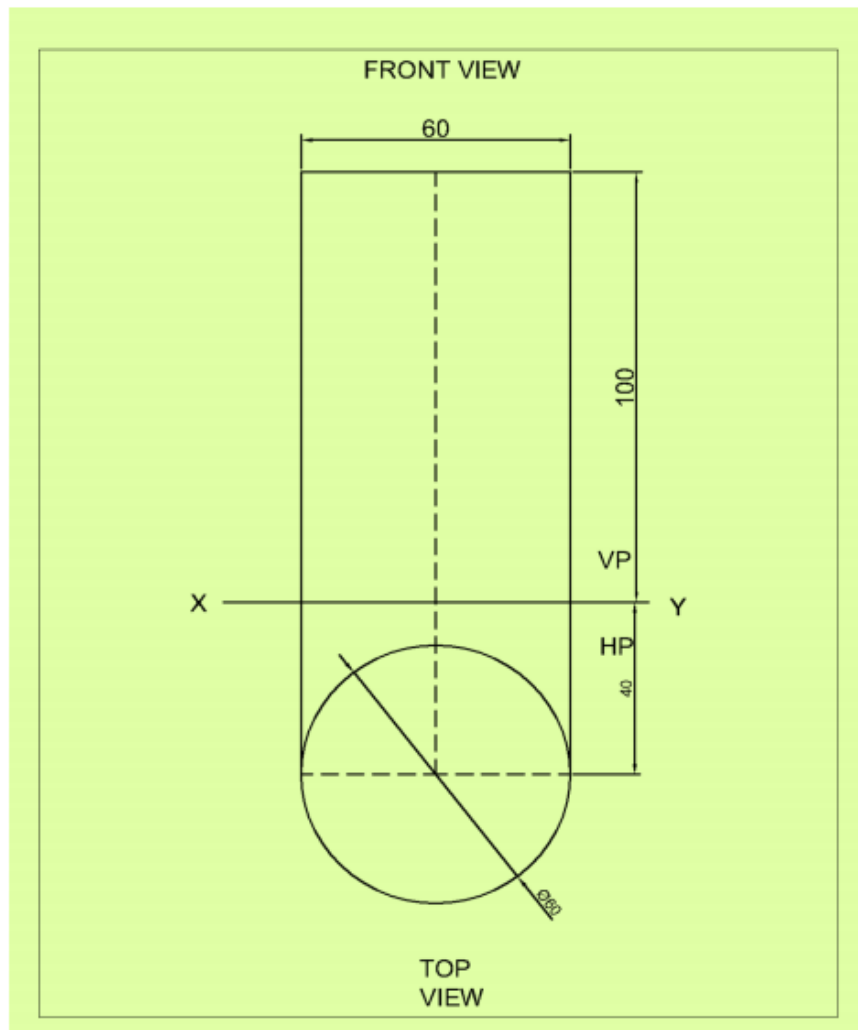


Q. No. 4.

A cylinder of base 60mm diameter and axis 100 mm long is resting on its base on the HP. The axis of the cylinder is 40mm in front of V.P. Draw the projections of the cylinder.

Solution :

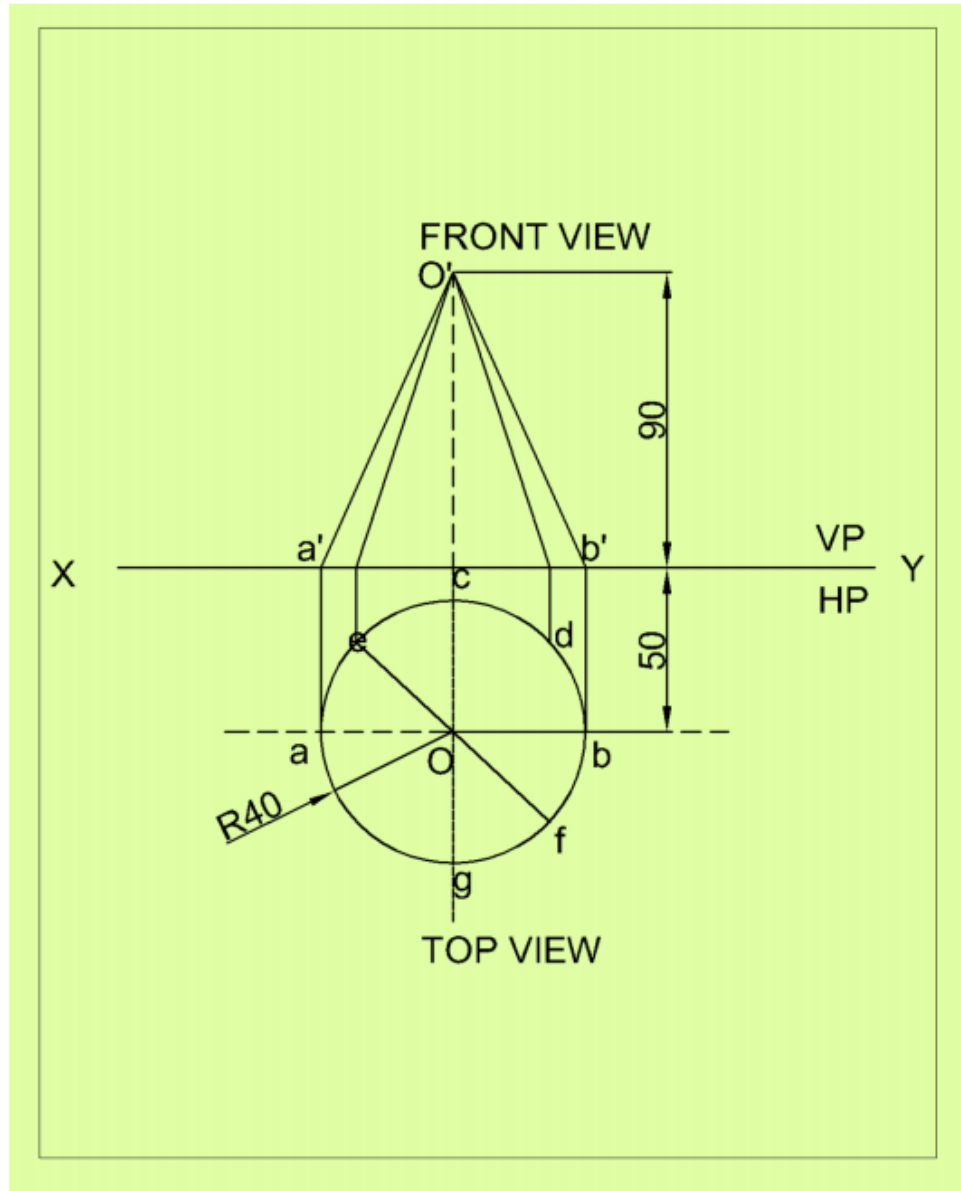
- i. As the axis of the cylinder is perpendicular to H.P, the top view must be drawn first and then the front view will be projected from it.
- ii. Draw a circle of diameter 60mm, representing the top view of the cylinder from a distance of 40mm from the XY.
- iii. From top view project the front view which is a rectangle of height 100mm, its base coincides with XY as shown.



Q. No. 5. Draw the projection of the right circular cone of base 80mm diameter and height 90mm resting with its base on H.P. and 50mm in front of V.P.

Solution :

- i. The top view gives the true size of the base, so the top view is draw first.
- ii. Draw the circle of about 80mm dia in a such a way that its axis is 50 below XY.
- iii. Project the front view from top view as shown.

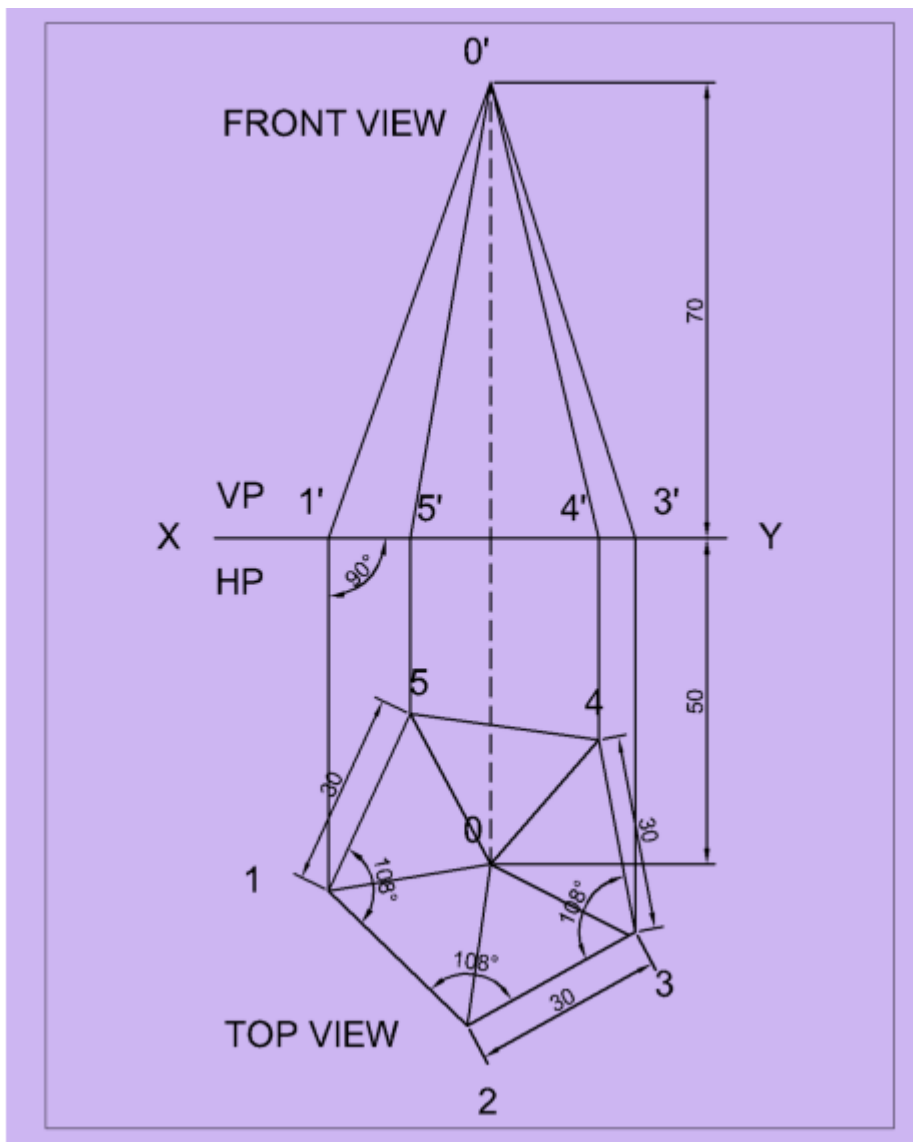


Q. No. 6.

Draw the projection of a right regular pentagonal pyramid of 30mm base and axis 70mm long is 50mm in front of V.P. The pyramid is resting on the H.P with one edge of the base perpendicular to the V.P.

Solution :

- i. As the pyramid is resting with base on H.P having axis perpendicular to the H.P, draw the top view of the pyramid keeping the axis 50mm in front of V.P. and edge perpendicular to the V.P.
- ii. Draw the pentagon 12345 of side 30mm.
- iii. Project the front view having height of the axis 70mm as shown.

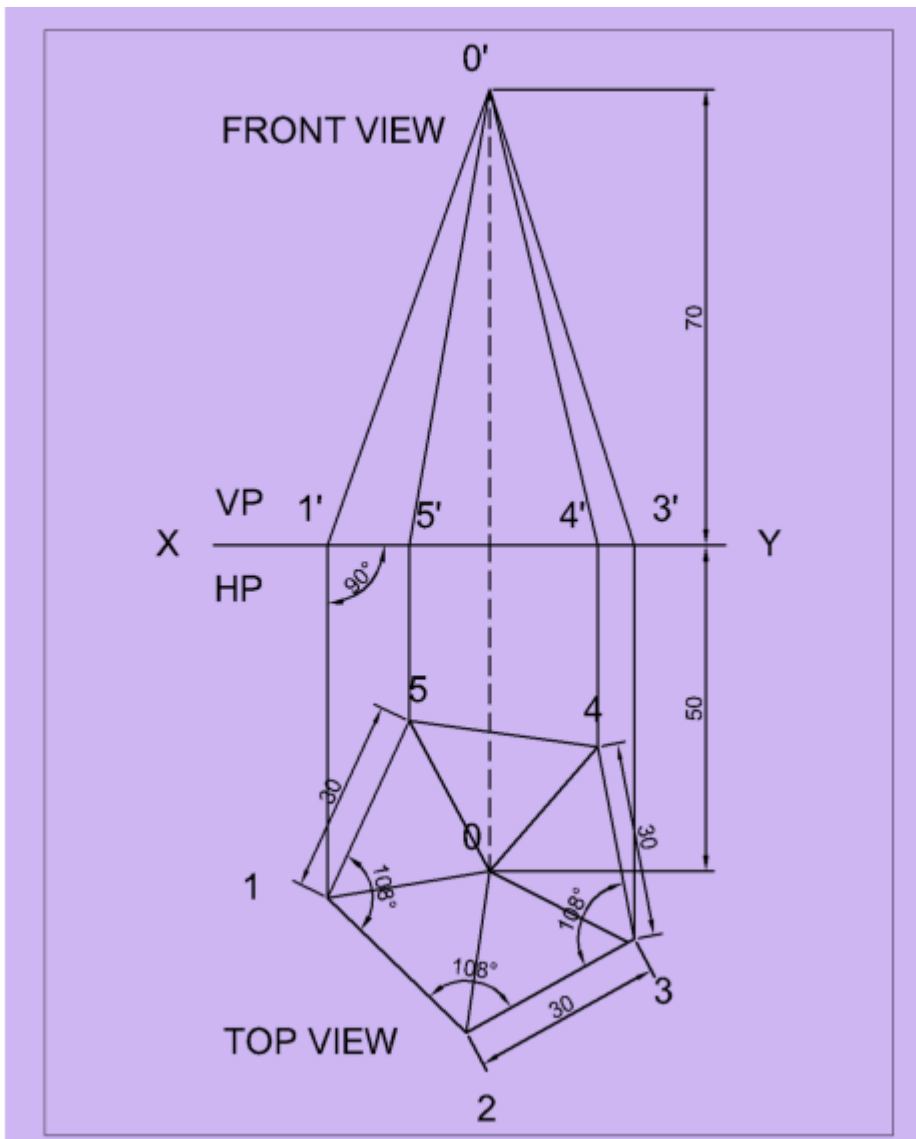


Q. No. 6.

Draw the projection of a right regular pentagonal pyramid of 30mm base and axis 70mm long is 50mm in front of V.P. The pyramid is resting on the H.P with one edge of the base perpendicular to the V.P.

Solution :

- i. As the pyramid is resting with base on H.P having axis perpendicular to the H.P, draw the top view of the pyramid keeping the axis 50mm in front of V.P. and edge perpendicular to the V.P.
- ii. Draw the pentagon 12345 of side 30mm.
- iii. Project the front view having height of the axis 70mm as shown.



CHAPTER 6

SECTION & DEVELOPMENTS

6.1 Draw the sectional projection & development of prism, cylinder, cone and pyramid in simple position by a cutting plane perpendicular to one reference plane and inclined to another reference plane.

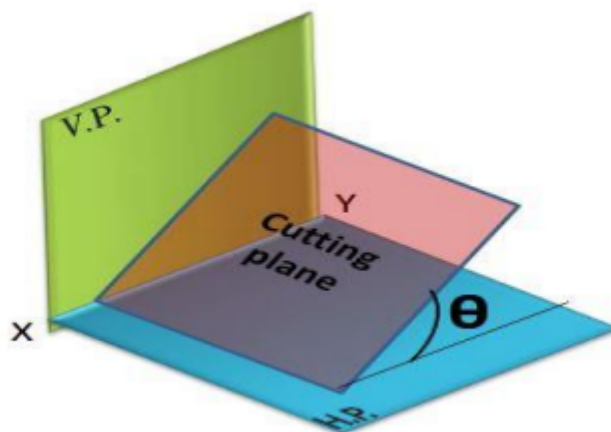
6.2 Draw the true shape of the cutting sections.

6.1 SECTIONING & DEVELOPMENT OF SOLID

An object (solid) is cut by some imaginary cutting plane to understand internal details of that object. The action of cutting is called **sectioning** a solid & the plane of cutting is called **section plane**.

The development of the surface of an object means the unrolling and unfolding of all surfaces of the object on a plane. If the surface of a solid is laid out on a plain surface, the shape thus obtained is called the **development of that solid**

SECTION PLANE PERPENDICULAR TO THE V.P. AND INCLINED TO THE H.P. :



**SECTION PLANE PERPENDICULAR TO THE H.P.
AND INCLINED TO THE V.P. :**

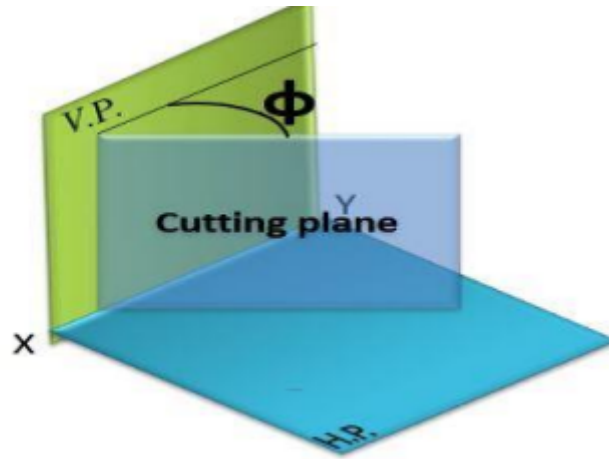
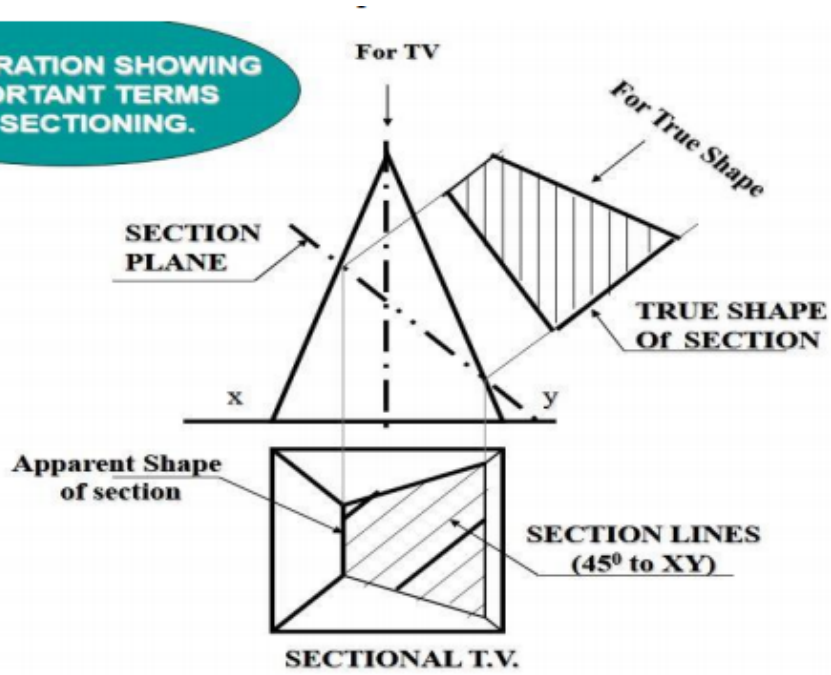


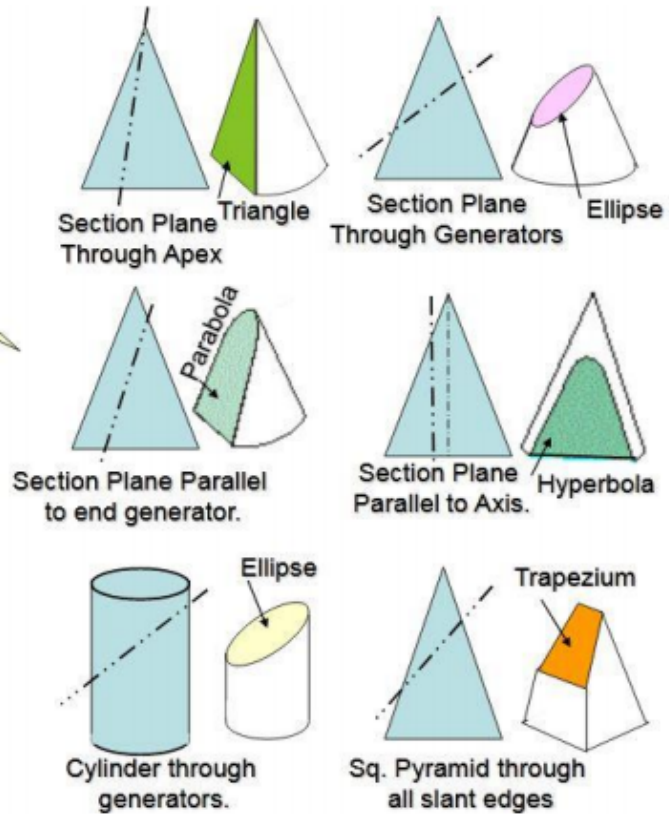
ILLUSTRATION SHOWING IMPORTANT TERMS IN SECTIONING.



(TV=TOP VIEW, FV=FRONT VIEW)

Fig 6.3

Typical Section Planes & Typical Shapes Of Sections.



6.2 SHAPE OF THE CUTTING SECTIONS

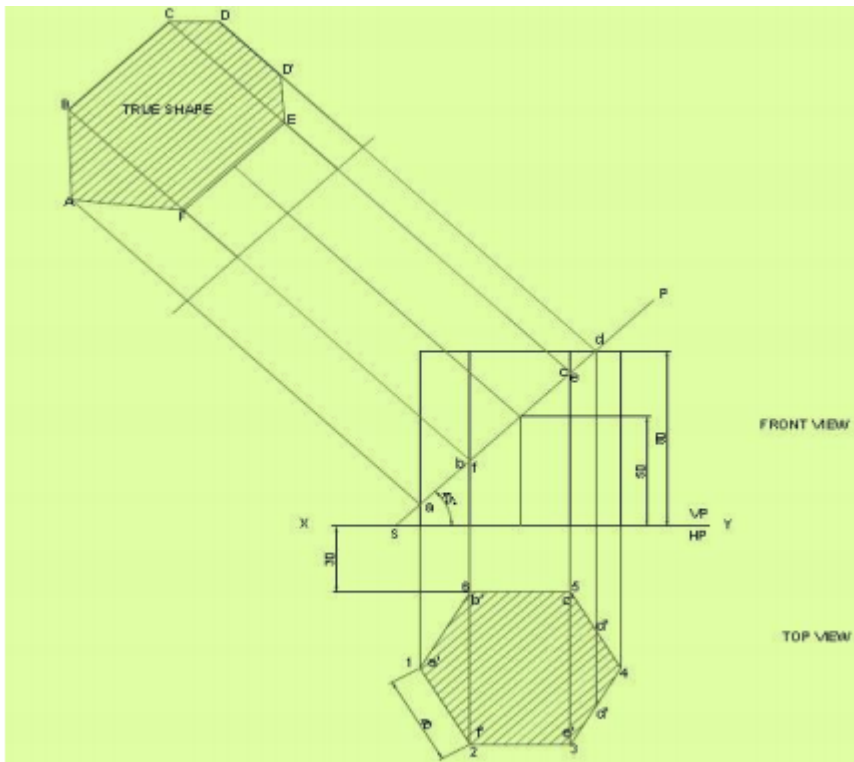
6.2.1 SECTIONAL PROJECTION OF PRISM

SOLVED PROBLEMS

Q. No. 1. Draw the front view, sectional top view and true shape of the section of a hexagonal prism of side 40 mm and 80 mm high lying on HP with a nearest side parallel to VP and 30 mm in front of it. It is cut by a plane perpendicular to VP and inclined to HP at an angle 45° passing through a point on the axis 50 mm above the base.

Solution :

- i. Draw the top view and front view of the hexagonal prism of base 40mm and axis 80mm.
- ii. Mark the point on the axis 50mm above the base and draw a cutting plane line through this point inclined at an angle 45° to HP.
- iii. Mark the numbering and point of intersection in front view and top view and transfer these points in the section plan and draw section lines in the cut portion in the top view.
- iv. Project the projection at right angle to the cutting plane line from the intersecting points and complete the true shape. Take distances equal to the corresponding distances on the plan and join the point and complete the true shape by drawing section lines.

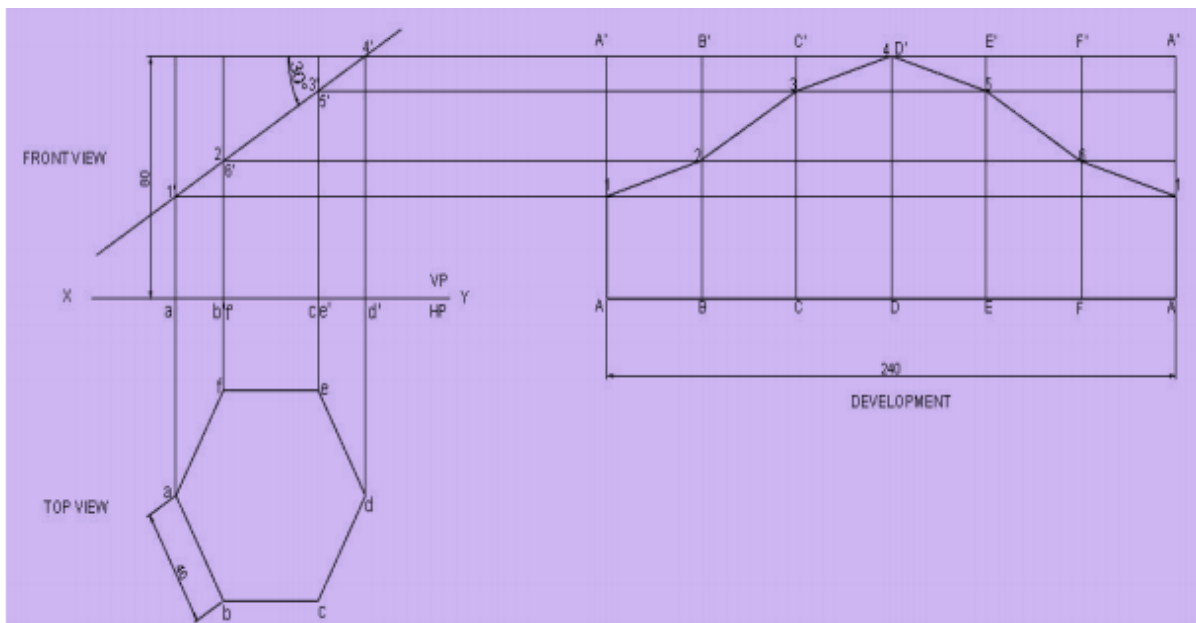


6.2.2 DEVELOPMENT OF PRISM

Q. No. 2. Draw the development of the lateral surface of the hexagonal cut prism of base 40 mm and axis 80 mm resting on HP in such a way that a rectangular face is parallel to VP. The section plane is perpendicular to VP and inclined at 30° to HP and passing through the top end of an extreme lateral edge of the prism.

Solution :

1. Draw the top and front view of the prism from the given data.
2. Draw the full stretched portion of length 240 mm. (6 x 40 mm).
3. Draw the section plane as per condition provided and do the proper nomenclature.
4. Project the points from front view to the full stretched portion and draw the development of the section

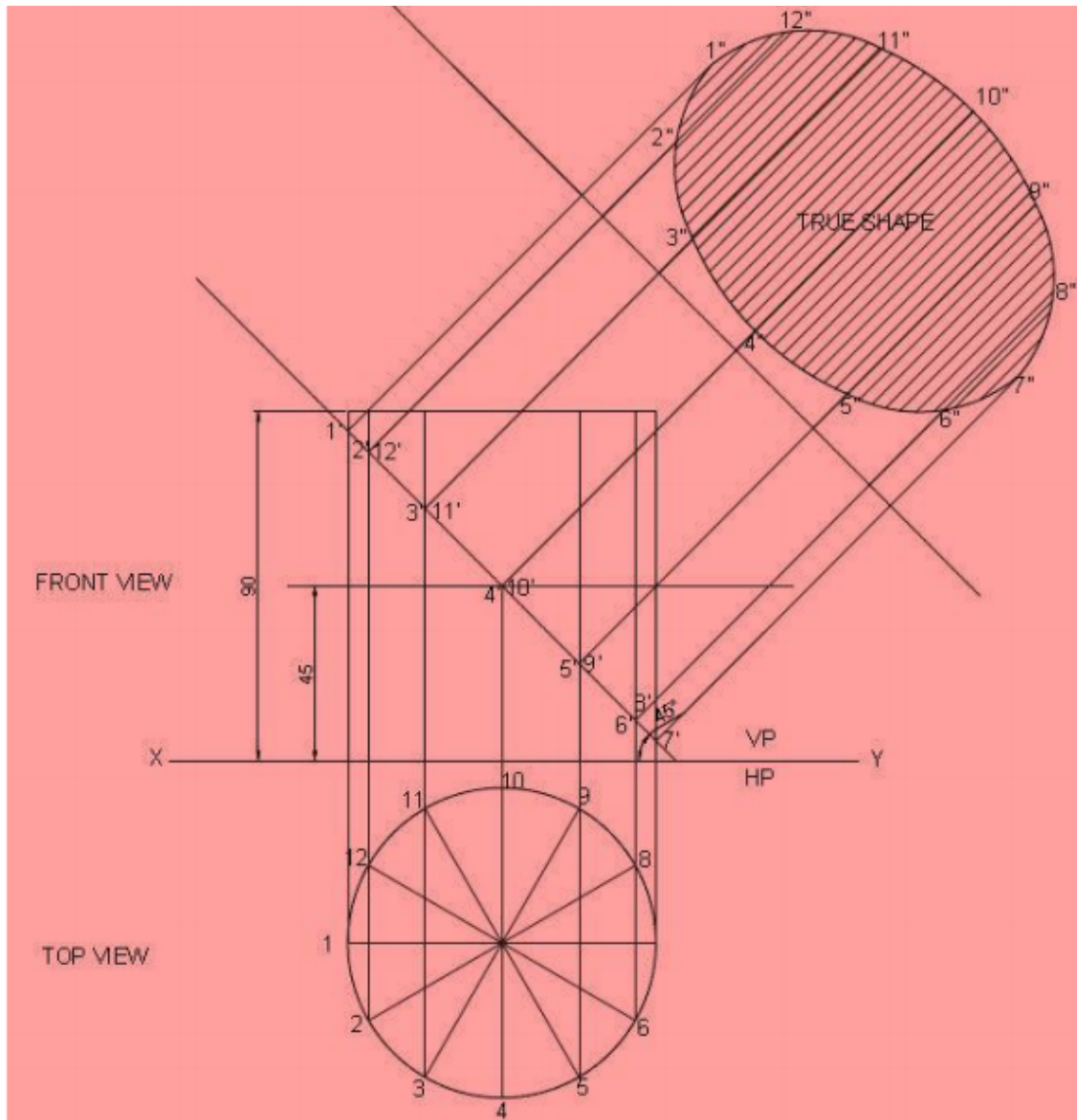


6.2.3 SECTIONAL PROJECTION OF CYLINDER

Q. No. 3. A cylinder 80 mm diameter and 90 mm long is resting on its base on ground. It is cut by a section perpendicular to VP. The VP of which cuts the axis at a point 45 mm from the base and makes an angle 45° to HP. Draw the sectional front view, sectional top view and true shape of the section.

Solution :

1. Draw the top view and front view of the cylinder with 80 mm diameter and 90 mm long.
2. Draw a section plane in such a way that it cuts the axis of the cylinder in front view at a distance of 45 mm base and makes 45° to HP.
3. Draw the projection for sectional top view and true sectional view as shown below.

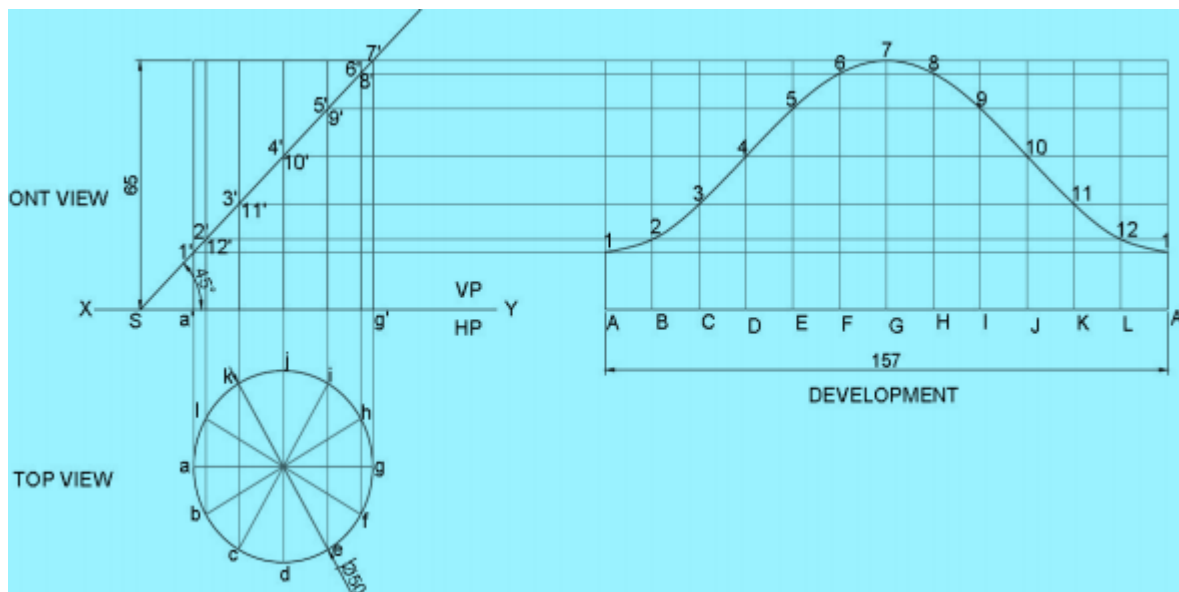


6.2.4 DEVELOPMENT OF CYLINDER

Q. No. 4. A right cylinder of 50mm diameter and 65 mm height is resting on its base on HP. It is cut by a section plane perpendicular to VP and inclined at 45° to HP in such a way that it passes through the top end of an extreme generator of the cylinder. Draw the development of the truncated cylinder.

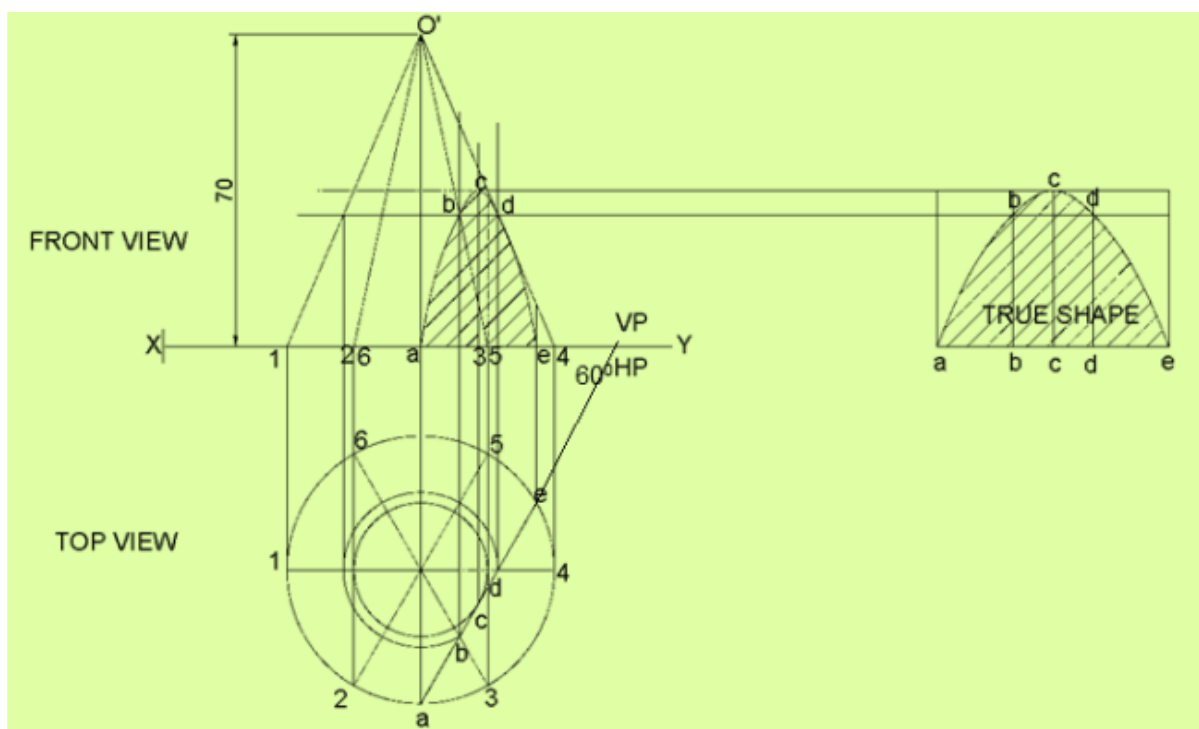
Solution :

- i. Draw the top view and front view of the cylinder.
- ii. Divide the circumference into 12 equal parts and locate the corresponding generators in the front view.
- iii. Draw the stretch out of the cylinder length and height.
- iv. Now the front view is cut by a section plane as per the given condition in the question as shown.
- v. Divide the stretch out and project the lines from the front view and complete the development as shown



6.2.5 SECTIONAL PROJECTION OF CONE :

Q. No. 5. A right circular cone of base diameter 60 mm and axis 70 mm is resting on H.P. It is cut by a section plane which makes an angle 60° to V.P. and passes through the point 15 mm from the axis. Draw sectional front view, top view, and true shape of section.

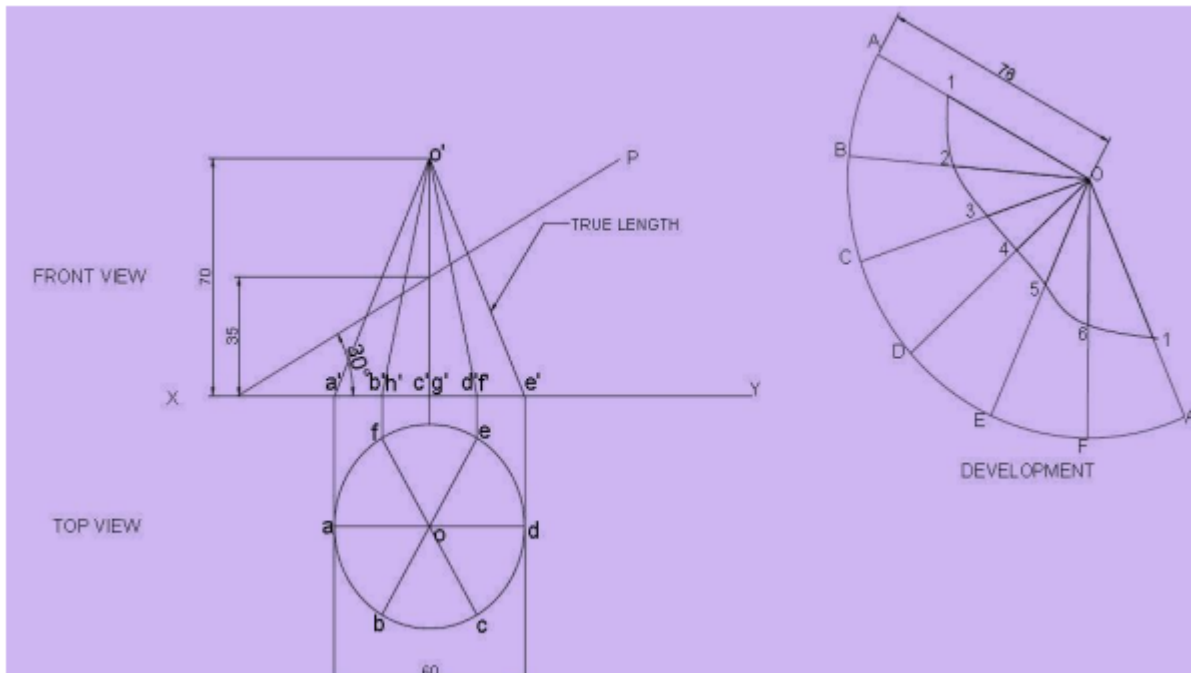


6.2.6 DEVELOPMENT OF CONE

Q. No. 6. A cone of base 60 mm dia. And height 70mm rests with its base on HP. A section plane perpendicular to VP and inclined at 30° to HP bisects the axis of the cone. Draw the development of the lateral surface of the truncated cone.

Solution :

- i. Draw the front view and top view of the cone of dia 60mm and height 70mm.
- ii. Now divide the top view i.e a circle into 12 equal no. of parts and name it.
- iii. Development of the cone is a sector of a circle of radius equal to the true length of slant height. The length of the arc is equal to the circumference of the base circle πD and the angle subtended at the centre (Θ).
 $\Theta = 360^\circ \times \frac{\text{Radius of base circle}}{\text{Slant height}}$ i.e. $\Theta = 360^\circ \times \frac{r}{l}$
- iv. Divide the arc in 12 parts and name accordingly.
- v. Draw the section plane at 30° to XY in such a way that bisecting the axis in front view.
- vi. Project the cutting plane as shown and complete the development



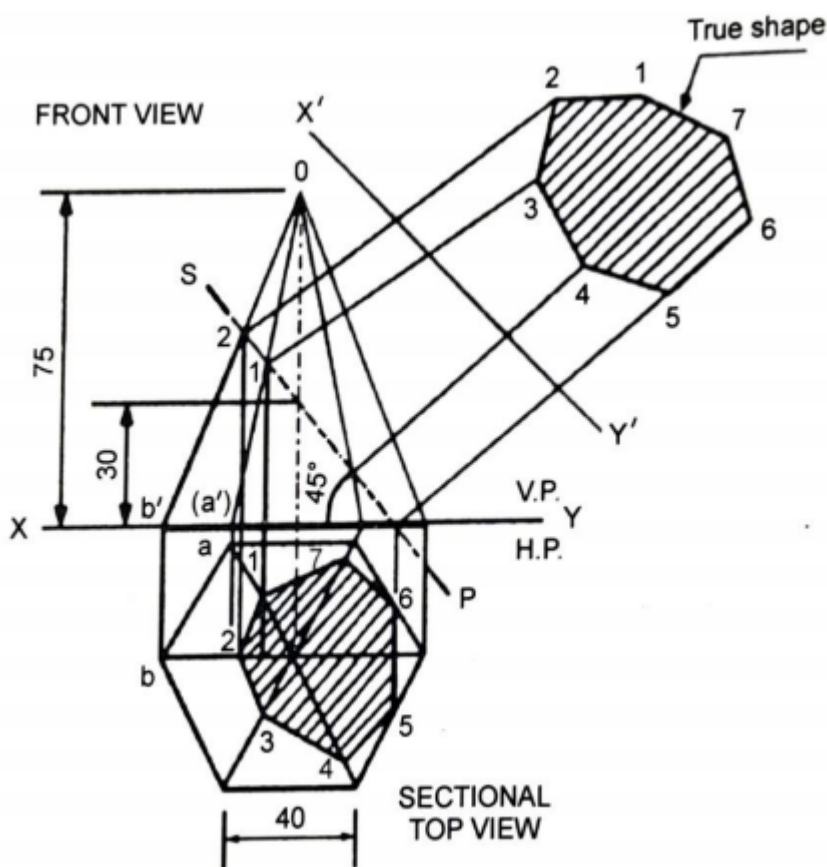
6.2.7 SECTIONAL PROJECTION OF PYRAMID

Q. No. 7. A hexagonal pyramid of side of base 40 mm and axis 75 mm long is resting on its base at HP with two edges parallel to the VP. It is cut by a section plane inclined at 45° to HP and passing through the axis at 30 mm from the base. Draw the projections of solid and show the true shape of the section.

Solution :

- I. Draw the top view and front view of the hexagonal pyramid of base 40 mm and axis 75 mm long resting on its base on HP.
- ii. Draw the section plane inclined at 45° to XY and passing through a point on the axis in such a way that it passes 30 mm from the base.

- iii. Locate the points of intersection between the section plane and edges of the pyramid.
- iv. Project and locate these points on the corresponding edges in the top view. Join the points in the order by straight lines and complete the sectional top view.
- v. To obtain the true shape of the section draw the reference line $X''Y''$ (auxiliary axis) parallel to the section plane.
- vi. Project the points through $X''Y''$ and obtain the true shape of the section as shown

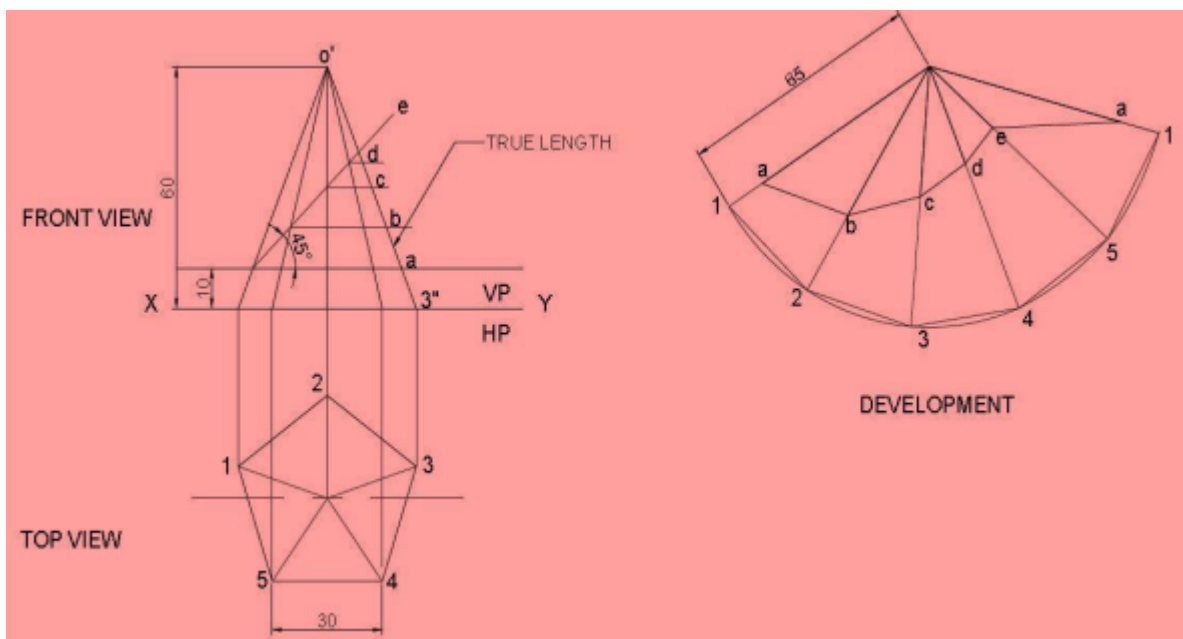


6.2.8 DEVELOPMENT OF PYRAMID :

Q. No. 8. A right regular pentagonal pyramid, edge of base 30 mm and height 60 mm is resting on its base in HP with axis parallel to VP. Two of its base edges are equally inclined to the VP. The pyramid is cut by a section plane at an angle of 45° to HP and 10 mm away from base on the edge of the corner. Draw the development of the surface.

Solution :

- i. Draw the top view and front view as per given condition.
- ii. Draw a section plane inclined 45° to HP, leaving a vertical distance of 10 mm from its base and name the parts.
- iii. Draw the development of lateral surfaces.
- iv. Draw an arc with radius equal to the true length of the edge in the front view.
- v. In the front view project the points on the true length and name the points and make the distance from the apex and transfer the distances on the develop



CHAPTER 7

ISOMETRIC PROJECTIONS

Draw isometric view & Isometric projection of prism, pyramid, cone & cylinder with axis horizontal and vertical with construction of isometric scales.

ISOMETRIC PROJECTIONS

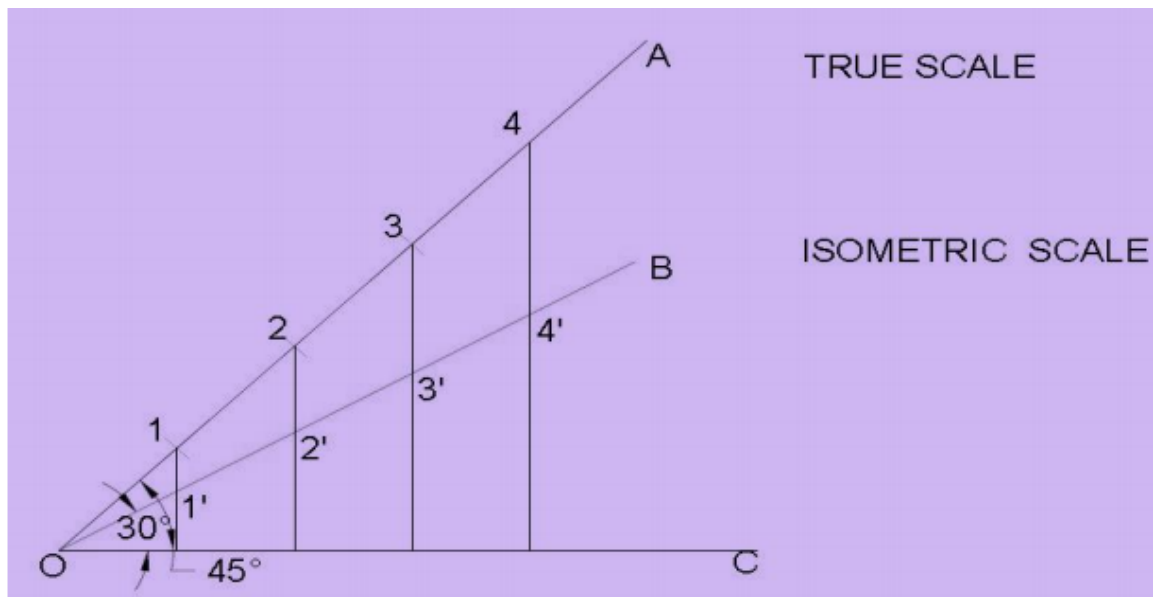
ISOMETRIC PROJECTION :

Isometric projection is a method for visually representing three-dimensional objects in two dimensions.

It is an axonometric projection in which the three coordinate axes appear equally foreshortened and the angle between any two of them is 120° .

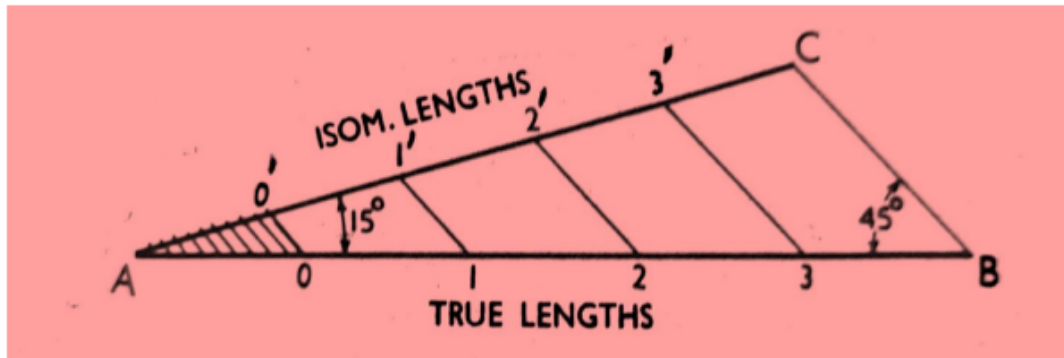
CONSTRUCTION OF ISOMETRIC SCALE

METHOD 1 :



- Draw a horizontal base line OC.
- Draw OB & OA which make 30° and 45° with OM respectively.
- On line OA marks the division points as 1,2,3,4,5.... with each division as 10 mm.
- From each division points draw perpendicular to OC ,intersecting the line OB at 1'',2'',3'',4'' and so
- on.
- Mark the corresponding points on OB obtaining the isometric scale.

METHOD 2 :



- Draw a horizontal base line AB.
- Draw AC which make an angle 15° with base AB and draw BC which make an angle 45° with AB
- respectively.
- On line AB mark the division points as 0,1,2,3,.... with each division as 10 mm.
- Draw parallel lines with BC from the points 0,1,2,3, .. , intersecting the line AC at $0''$, $1''$, $2''$, $3''$ and so on.
- Measure the isometric lengths on the isometric scale on the line AC.

NOTE :

ISOMETRIC VIEW : It is drawn by using full/true scale.

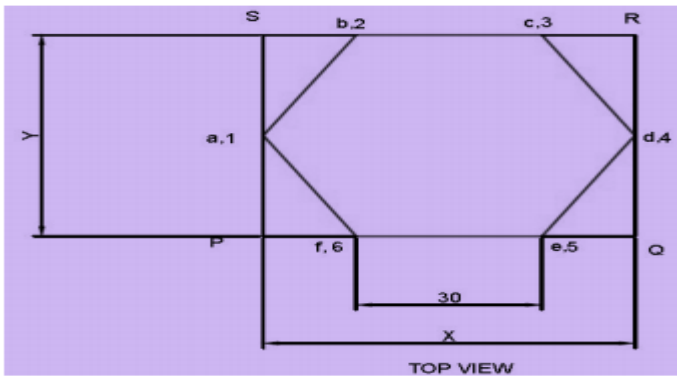
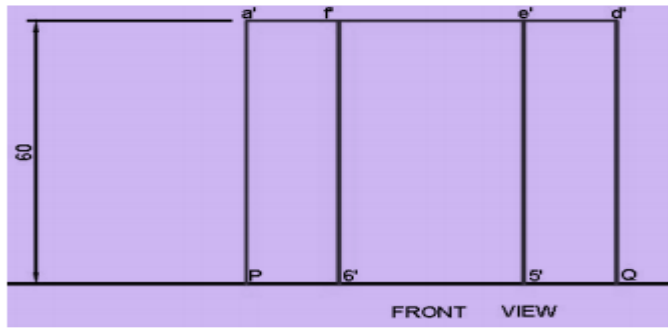
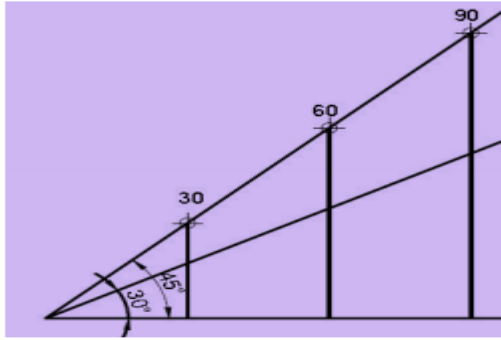
ISOMETRIC PROJECTION : It is drawn by using isometric scale.

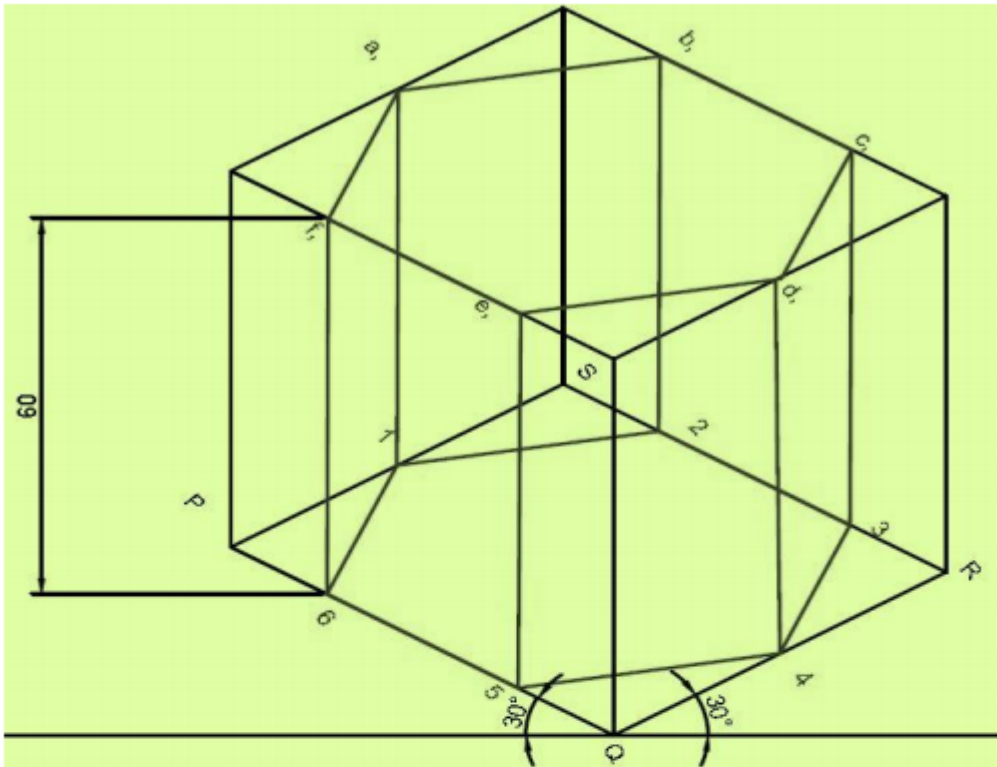
ISOMETRIC VIEW & ISOMETRIC PROJECTION OF PRISM WITH CONSTRUCTION OF ISOMETRIC SCALES :

Q. No.1. A hexagonal prism having the side of base 30 mm and the height of 60 mm is resting on HP and with an edge of the base parallel to VP. Draw its projections and also prepare the isometric view of the prism with the axis in vertical position.

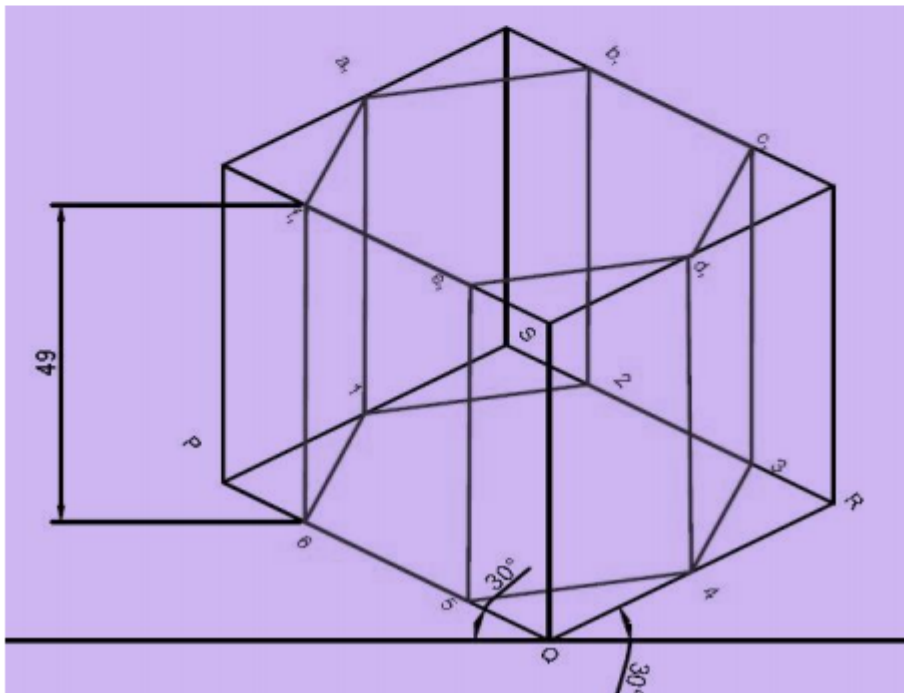
STEPS :

- Draw the true scale and isometric scale as explained to represent the distance.
- Draw the top view of hexagon (a1,b2,c3,d4,e5,f6) with base 30 mm and box it by a rectangle
- PQRS.
- Draw the front view of the prism with height taken as 60 mm.
- Draw the isometric view of the hexagonal prism with the axis in vertical position as shown.
- For the isometric projection, take the base and height dimension from isometric scale.





ISOMETRIC VIEW



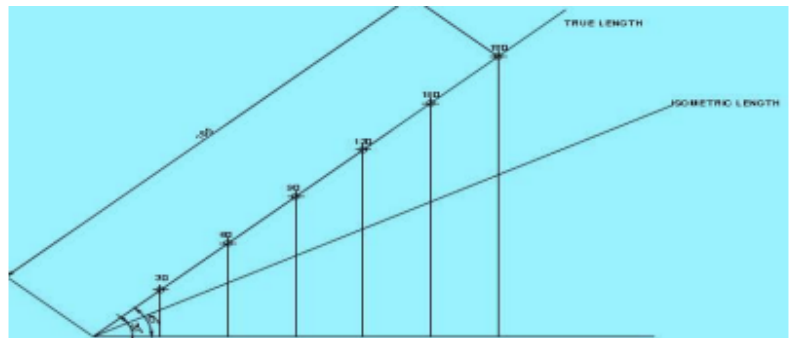
ISOMETRIC PROJECTION

ISOMETRIC VIEW & ISOMETRIC PROJECTION OF PYRAMID WITH CONSTRUCTION OF ISOMETRIC SCALES :

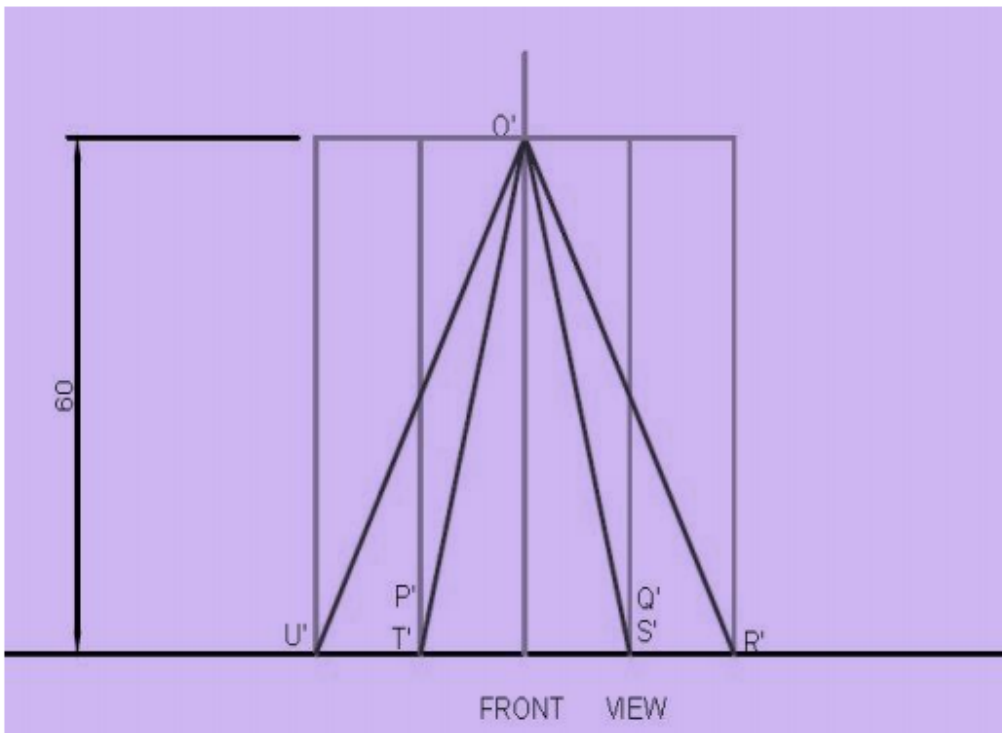
Q. No. 2. A hexagonal pyramid having the side of base 30 mm and the height of 60 mm is resting on HP and with an edge of the base parallel to VP. Draw its projections and also prepare the isometric view of the pyramid with the axis in vertical position.

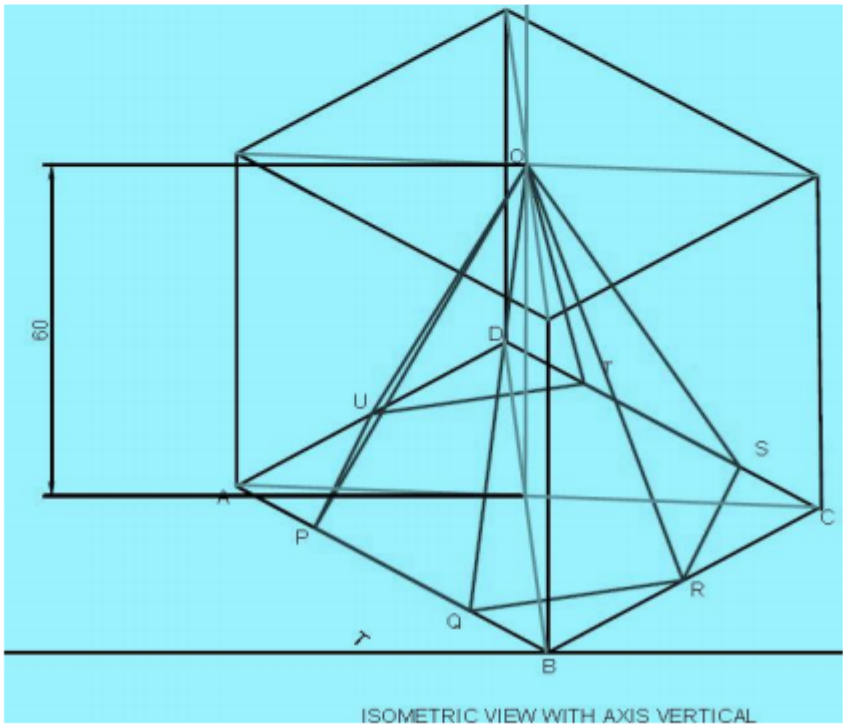
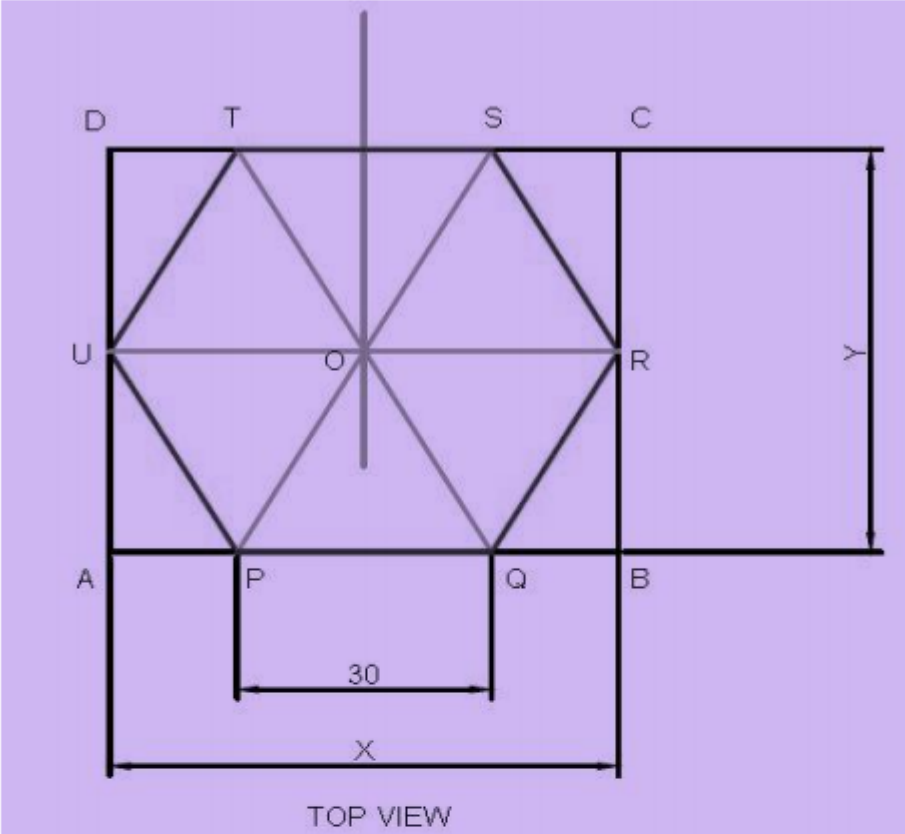
STEPS :

- Draw the true scale and isometric scale as explained to represent the distance.
- Draw the top view of the hexagon (PQRSTU) with base 30 mm and box it by a rectangle ABCD.
- Draw the front view of the pyramid with height taken as 60 mm.
- Draw the isometric view of the hexagonal pyramid with the axis in vertical position as shown.
- For the isometric projection, take base and height dimensions from the isometric scale.



SCALE



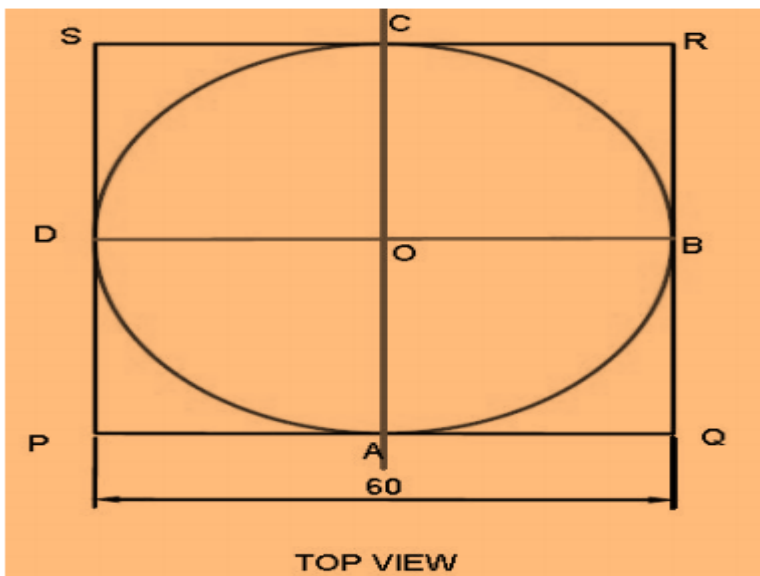
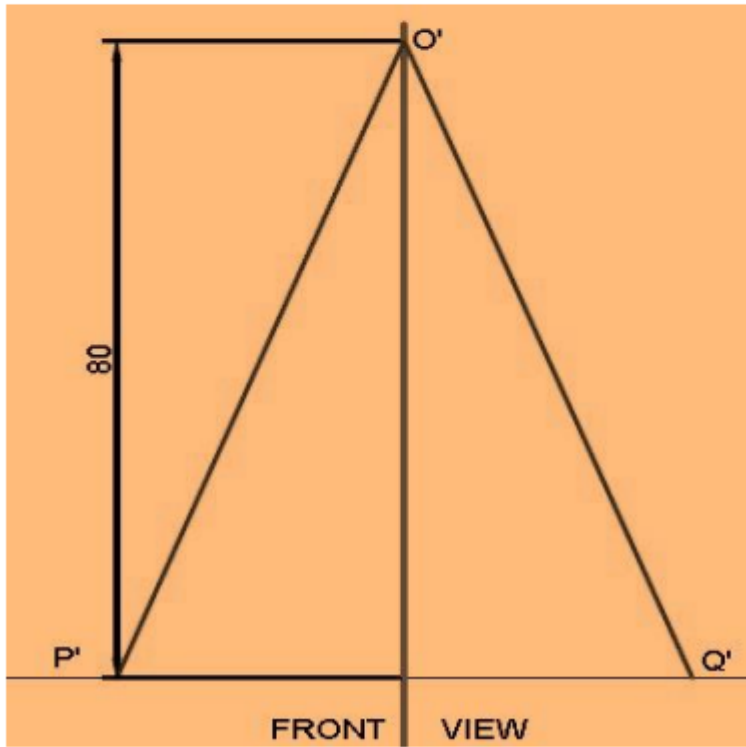
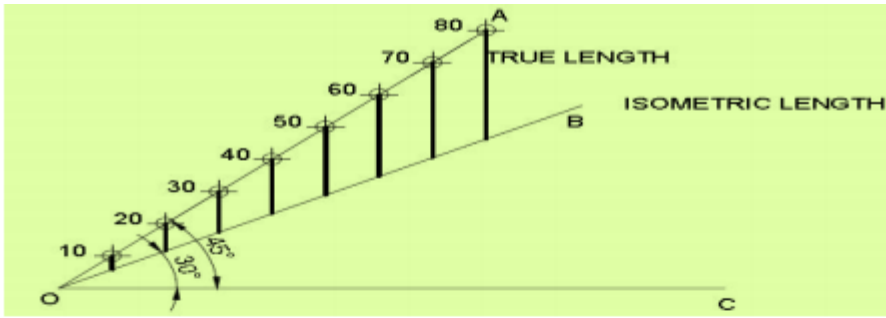


ISOMETRIC VIEW & ISOMETRIC PROJECTION OF CONE WITH CONSTRUCTION OF ISOMETRIC SCALES :

Q.No. 3. A cone having the side of base 60 mm and the height of 80 mm is resting on HP. Draw its projections and also prepare the isometric view of the cone with axis in horizontal position.

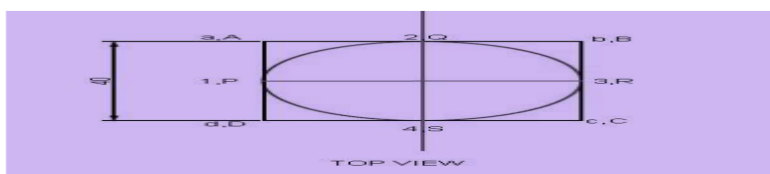
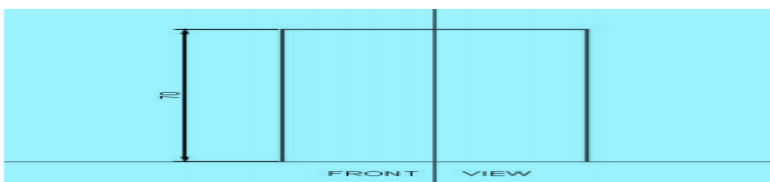
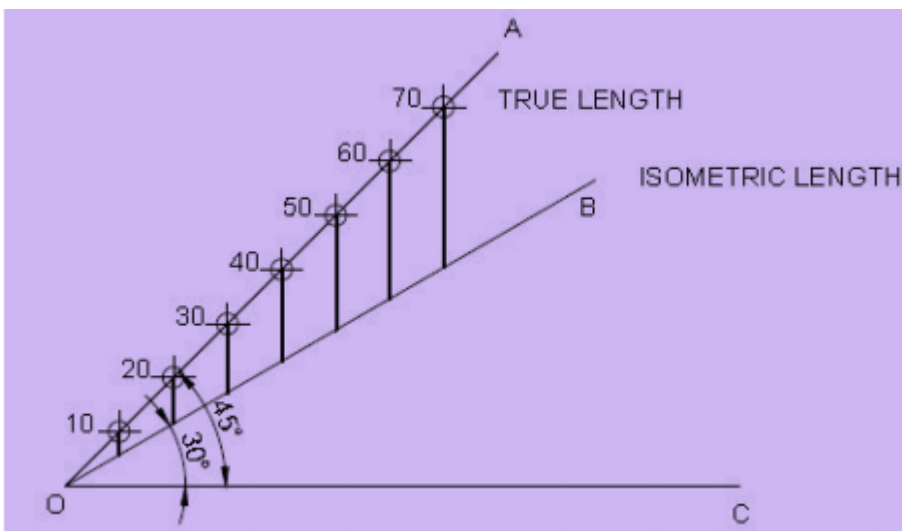
STEPS :

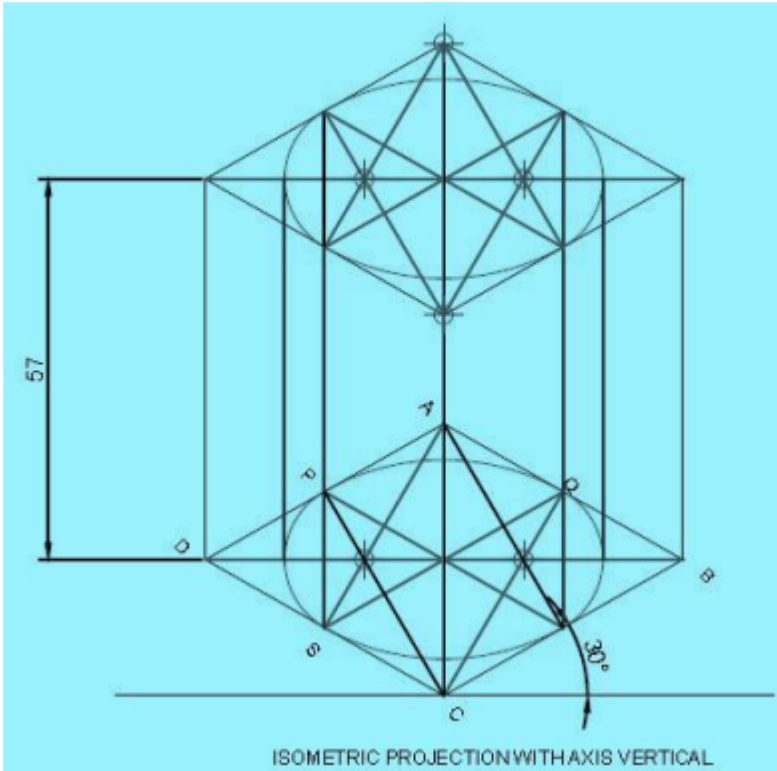
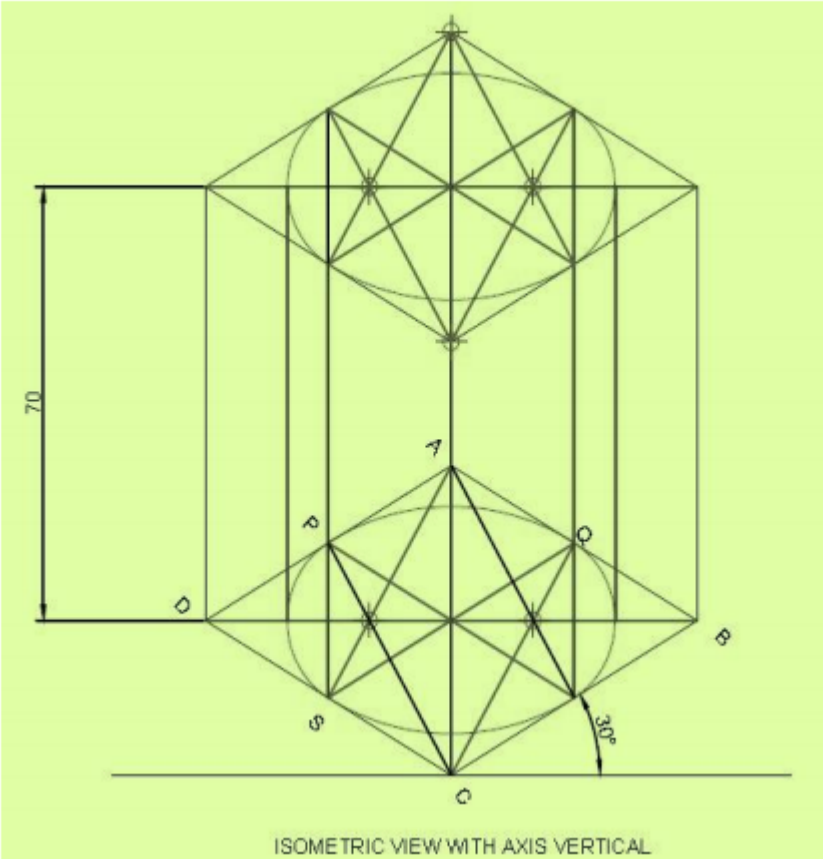
- Draw the true scale and isometric scale as explained to represent the distance.
- Draw the top view of the cone (ABCD) with base 60 mm and box it by a rectangle PQRS.
- Draw the front view of the cone with height taken as 80 mm.
- Draw the isometric view of the cone with the axis in horizontal position as shown. Use four point
- method to draw a circle in an isometric view.
- For the isometric projection take diameter and height dimension from isometric scale.



STEPS :

- Draw the true scale and isometric scale as explained to represent the distance.
- Draw the top view of cylinder (PQRS) with base 40 mm and box it by a rectangle ABCD.
- Draw the front view of the cylinder with height taken as 70 mm.
- Draw the isometric view of the cylinder with axis in vertical position as shown. Use four point method to draw circle in isometric view.
- For the isometric projection take diameter and height dimension from isometric scale.





CHAPTER 8

BUILDING DRAWING

8.1 Explain terms related to building drawing.

8.2 Draw plan, elevation of single room building with verandah (Flat roof according to given line plan and specification).

8.1 TYPES OF BUILDING

1. Residential Building: Residential building means a building in which sleeping accommodation is provided for normal residential purposes, with or without cooking or dining facilities, and includes one or more family dwellings, lodging or boarding houses, dormitories, apartment houses, flats .

2. Non-residential Building: Non-residential building means a building not used as a dwelling.

3. Community Hall/ Commercial Building: Commercial buildings are buildings that are used for commercial purposes, and include office buildings, warehouses, and retail buildings.

A commercial building definition is one in which at least 50 percent of its floor space is used for commercial activities, such as retail, the providing of services, or food service (restaurants and the like).

8.2 TERMS RELATED TO BUILDING DRAWING

8.2.1. Line Plan :

- In this drawing, the position and size of internal rooms are given. Such drawing is prepared
- with a single line. The thickness of the walls is not shown in it.
- The dimension given in the rooms is their internal ones which do not include the thickness of
- walls.
- The dimension given outside the rooms is their external ones which include the thickness of
- walls.
- The first dimension represents a horizontal dimension of the room while the second
- represents a dimension normal to horizontal.

- To represent the height of a room, it is written in a circle.
- The doors and windows are represented in the related places with size.
- The details given in the line diagram are used to draw the building drawing.

8.2.2. Plan :

1. In this type of building drawing the size, arrangement, and position of rooms and veranda is shown.
2. Plan is generally the top view of the building.
3. It is obtained by cutting the building at window sill level by a horizontal cutting plane and then, removing the upper part of the building and then, the top view of remaining is projected on the horizontal plane (HP).

8.2.3. Elevation :

Elevation or front view is the outward view of a completed building along any side of the building. When a building is seen by standing in front of it, the view that can be viewed is projected on the vertical plane (VP) is called front elevation.

Similarly the backside view is called rear elevation or from any side of it which is known as side elevation.

8.2.4. Section:

Section is also known as vertical section and sectional elevation or cross section.

It is imagined that a finished buildings is cut vertically along a line so that the building is separated into two portions along the imagined vertical plane right from top of the building to the lowest part of the foundation.

The view that can be seen while travelling along this imaginary vertical plane when looking towards the left is drawn to the same scale as that adopted for the plan.

8.3 TERMS RELATED TO BUILDING

8.3.1.Substructure :

1. The portion of the building or structure, which lies below the ground level, is termed as substructure also called foundation.

8.3.2.Super-Structure :

1. The portion of the building or structure, which lies above the ground level, is termed as superstructure.

8.3.3. Plinth :

1.The portion of a building between ground level (GL) and floor level (FL) is called plinth/plinth wall and the height is called plinth height.

2.If the thickness of the plinth wall is more than the superstructure wall, then the projected portion The plinth wall from the superstructure wall is called plinth projection.

3.Generally plinth height of 450mm/600mm is provided.

8.3.4. Lintel :

1.It is the element of the building, which is provided over the small openings of the doors/windows/ verandah to transfer the load coming over them onto the wall on which they rest.

2.Its size depends on the opening size of doors/windows/verandah. In some cases it is provided throughout the wall.

3.Depth of lintel is generally 150mm.

8.3.5.Chajja/Sun shade :

1.It is the horizontal/sloping element of the building provided above the openings on external walls and projected from the lintel outward to provide protection from sun and rain.

2.Chajja is constructed using RCC.

3.Thickness and width of a horizontal chajja is 75mm and 450mm respectively.

8.3.6.Ceiling Height:

1. The height of a room from the floor level to the soffit of ceiling is called ceiling height.

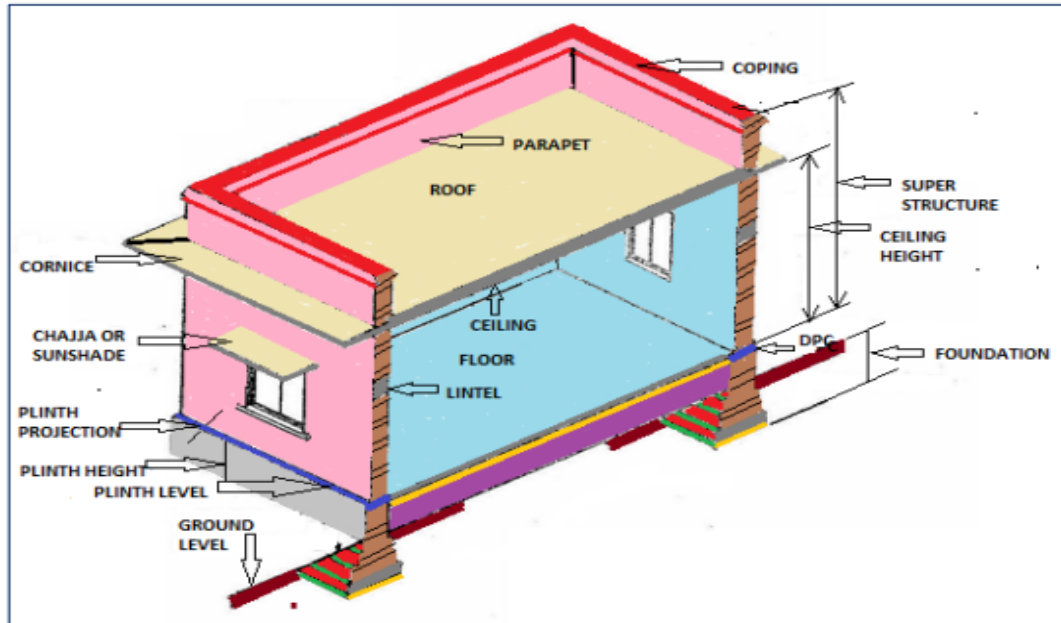


Figure 8.1: Main Parts of One Storied Building

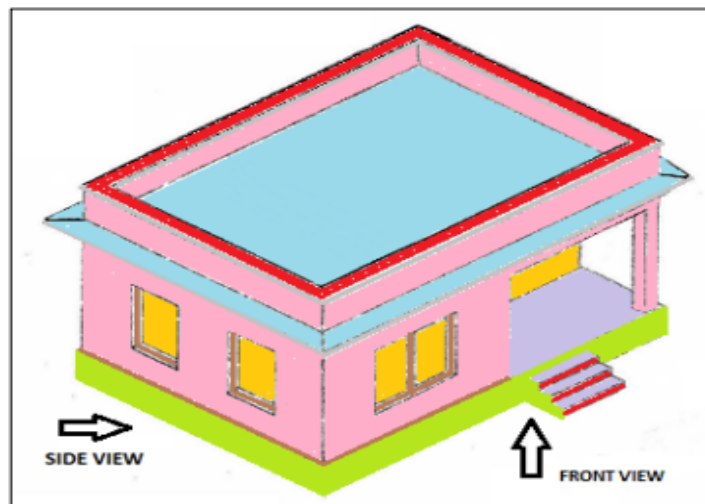


Figure 8.2 : Front View and Side View

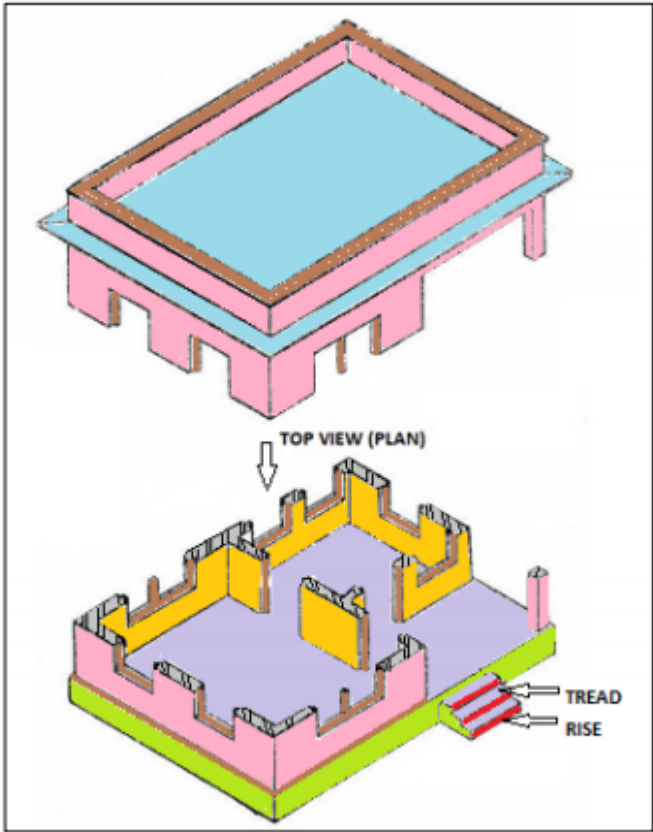


Figure 8.3: Top View

Q. No. 1.

Draw the plan and elevation of the building from the line plan and specifications as given below.

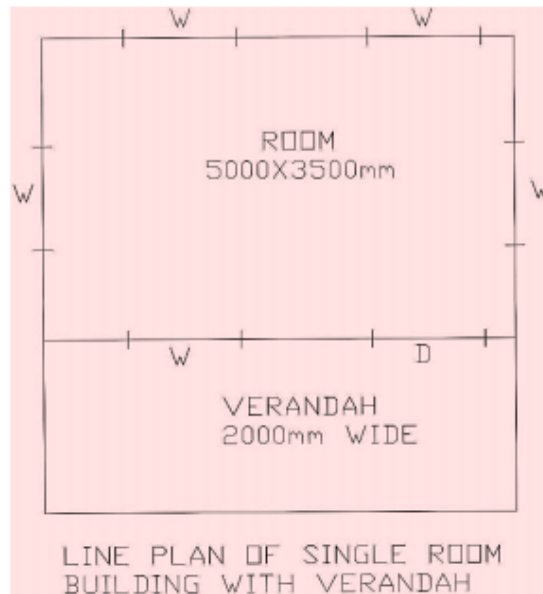


Figure 8.3

Specifications :

1. Wall Thickness – 300 mm
2. Plinth height – 600 mm
3. Plinth thickness – 400 mm
4. Steps
 - i. Trade – 300 mm
 - ii. Riser – 150 mm
5. Ceiling Height for room and verandah – 3000 mm
6. Masonry pillars – 300 mm X 300 mm
7. Spacing of masonry pillars should not exceed 3000 m
8. Roof slab thickness – 120 mm
9. Roof slab projection (cornice) – 120 mm
10. Chajja
 - i. Thickness – 75 mm
 - ii. Width – 450 mm
11. Size of Doors and Windows

i. Window(W) – 1200 mm X 1350 mm

ii. Door(D) – 1200 mm X 2100 mm

12. Size of chauth for doors and windows – 80 mm X 100 mm

Solution :

Steps for drawing Plan

1. First of all choose a suitable scale then convert all the dimensions as per the scale.

2. After that, imagine that the building is cut by a horizontal plan at window sill level and after removing the top portion the remaining portion is the plan.

3. Then, the various elements of the building like the wall, windows, door, column, step etc. are

projected on a horizontal plan (HP) keeping it below the reference line (XY) as per the principle of first angle projection which is the required plan as shown in the figure 8.4 in next page.

4. The elements of the building, which are above the window sill level, are also shown in the plan as hidden lines (i.e. by dashed line) for example, the chajja or sun shade.

Steps for drawing Elevation

- Imagine that observer is standing in front of the above building and keeping the vertical plane (VP)
- behind it the front portion of the building is projected on to the VP.
- The figure so obtained on the VP is the front elevation.
- As per the principle of first angle projection the front elevation is drawn just above the plan.
- Thus, from the plan vertical lines from plinth wall, wall, pillar, etc. are projected. These lines are cut
- by horizontal lines at different height to get the elevation of different elements present in the front

- portion of the building. The required elevation is as shown in the figure 8.4 in the next page.

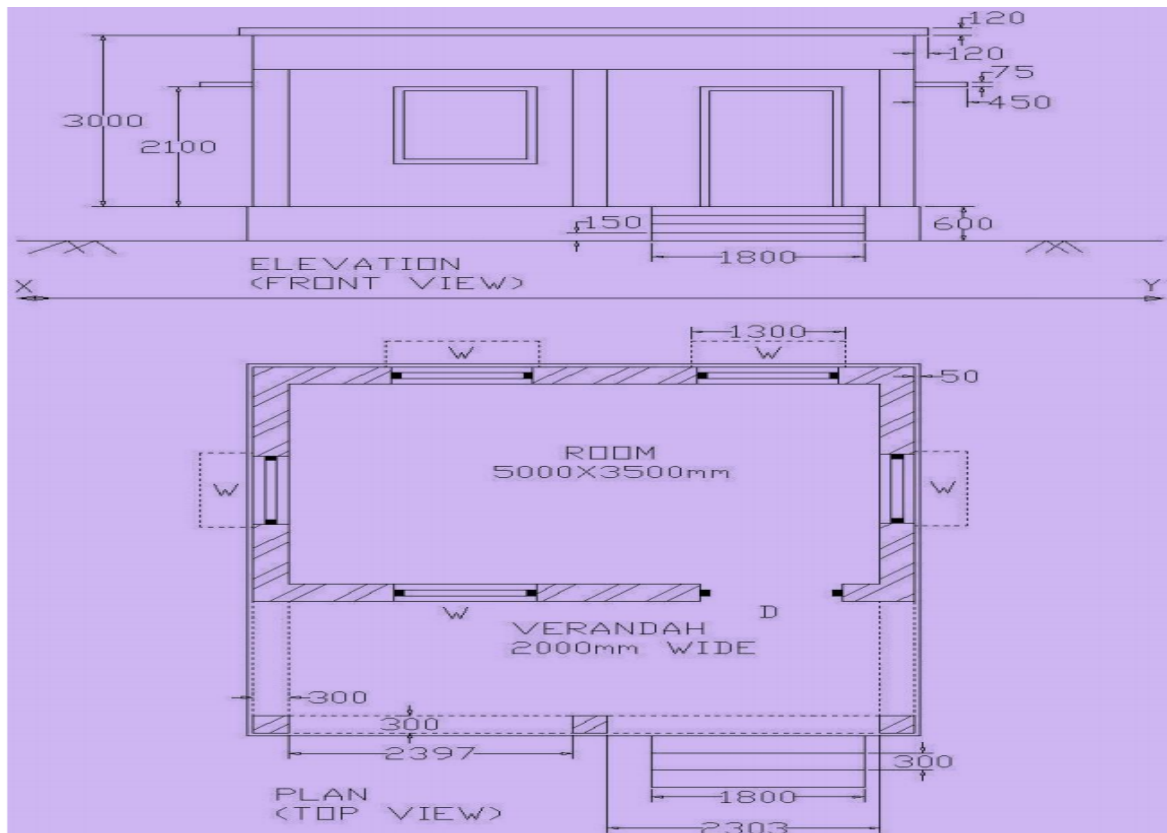


Figure 8.4 (All Dimensions are in mm)

CHAPTER 9

PRACTICES ON AUTOCAD

9.1 Introduction-Settings, Limits etc.

9.2 Auto CAD commands Draw commands (Line, circle, polygon, ellipse, rectangle). Edit command, Dimension commands and Modify Commands for two dimensional drafting only.

9.3 Exercise for practice using AutoCAD.

9.3.1 Orthographic projections of lines, planes and solids as per chapter 5.0

9.3.2 Isometric projection as per Chapter 7.0

9.1

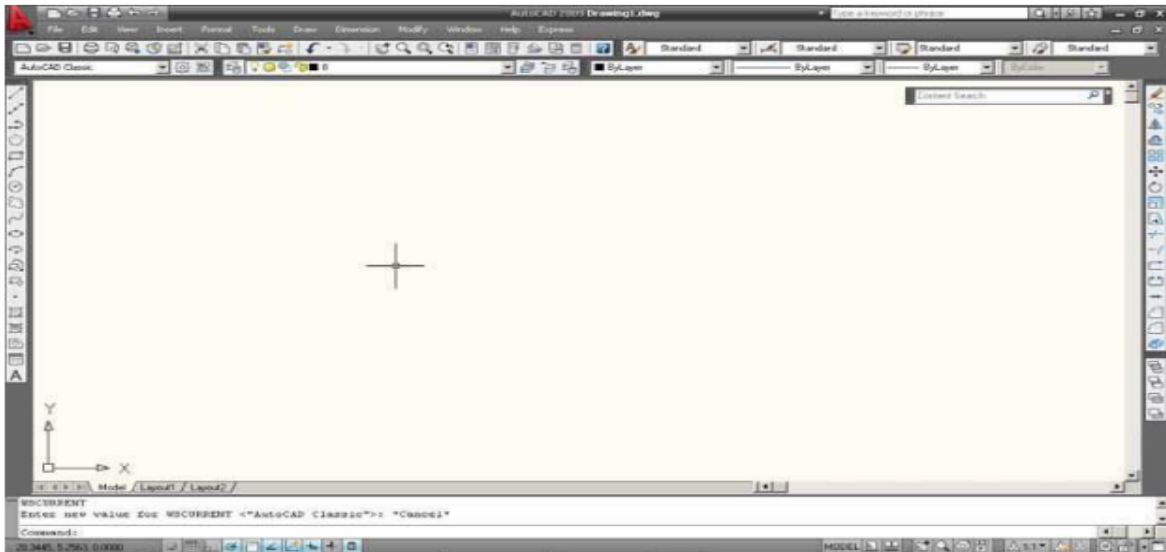
INTRODUCTION

In a little over a generation's time the methods used to create technical drawings have fundamentally changed from using pencil and paper to the use of Computer Aided Drafting, better known as CAD. The analog world of drafting boards, T squares, triangles, and even the romantic french curve has given way to the brave new digital world of computers. Using CAD, you can draw something once and copy it hundreds, or even thousands, of times. Changing a design can be as simple as pushing a button. Drawings can be shared instantaneously across the room or even around the world over a computer network. Developed and marketed by Autodesk, **AutoCAD** was first released in December 1982 as a desktop app running on microcomputers with internal graphics controllers. It has been subsequently revised and up-graded.

9.2

LAUNCHING OR OPENING AUTOCAD

Starting AutoCAD You can start AutoCAD by either double clicking on the program Icon on the desktop or by clicking on the program name in the Start menu. The program will start and after a minute or so should display a screen similar to the one shown below.



9.3 POINTING DEVICE MOUSE

AutoCAD uses either a mouse or digitizing tablet to select objects in a drawing.

9.3.1 Left Mouse Button

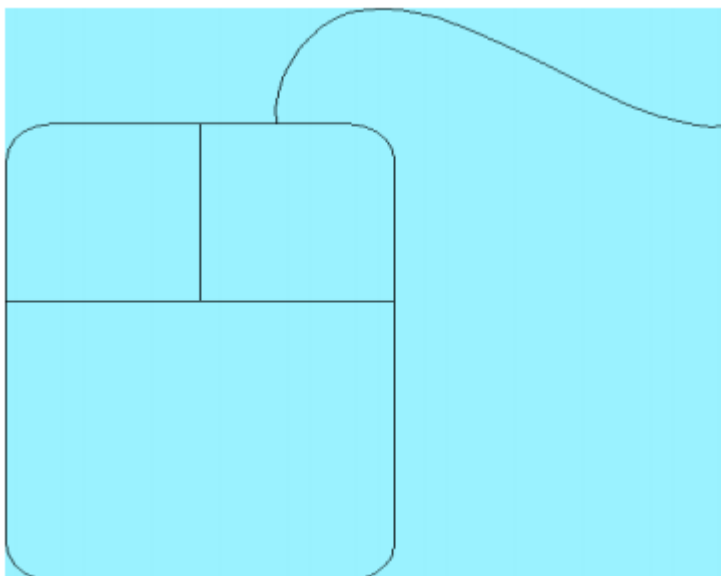
Used to pick or select objects.

1. Click the left mouse button to select an object area in the drawing.
2. Press **ESC** twice to deselect an object (or to cancel a command).

9.3.2 Right Mouse Button

Used to enter a command, repeat last command, or access shortcut menus.

1. Click the right mouse button.



9.4 TYPING COMMANDS

All AutoCAD commands can be typed in at the command line. Many commands also have one or two letter aliases that can also be typed as shortcuts to the commands.

Command : LINE

1. Type the desired command at the command prompt. or
2. Type the command's alias. Command: L
3. Press ENTER/Space to end.
4. Type an option at the command prompt.

TIP : Many AutoCAD commands require you to press ENTER to complete the command. You know you are no longer in an AutoCAD command when you see a blank command line.

9.4.1 Reusing the Last Command

The last used AutoCAD command can be re-entered by one of the following three methods of ENTER. The ENTER key on the keyboard will always act as ENTER, the SPACEBAR and RIGHT MOUSE will act as enter most of the time (exceptions include placing TEXT).

1. Press the **ENTER** key on the keyboard or
2. Press the **Space bar** on the keyboard. or
3. Click the **right** mouse button.

9.4.2 Menu browser

Menu browser is represented by the letter A in red. It provides recently accessed documents. It consists of the file, open, save, save as, export, print, drawing utilities etc.

9.4.3 Quick access toolbar :

It includes commonly used options such as new, open, save, plot, undo, and redo etc.

9.5 WORKSPACES

It is a collection of menus, toolbars, palettes & ribbon controls panel that are grouped and organized so that you can work in a custom, task-oriented drawing environment. Four types work spaces are defined in Autocad. Those are

1. Drafting & Annotation
2. 3D Modeling
3. 3d basics
4. AutoCAD Classic

9.5.1 Function Keys and Accelerator Keys

F1	Displays Help
F2	Toggles Text Window
F3	Toggles OSNAP
F4	Toggles TABMODE
F5	Toggles ISOPLANE
F6	Toggles UCSDETECT
F7	Toggles GRIDMODE
F8	Toggles ORTHOMODE
F9	Toggles SNAPMODE
F10	Toggles Polar Tracking
F11	Toggles Object Snap Tracking
F12	Toggles Dynamic Input

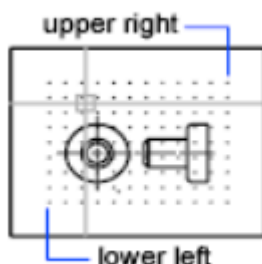
ALT+F11	Displays the Visual Basic Editor
ALT+F8	Displays the Macros dialog box
CTRL+0	Toggles Clean Screen
CTRL+1	Toggles Properties palette
CTRL+2	Toggles DesignCenter
CTRL+3	Toggles the Tool Palettes Window
CTRL+4	Toggles Sheet Set Manager
CTRL+5	Toggles Info Palette
CTRL+6	Toggles dbConnect Manager
CTRL+7	Toggles Markup Set Manager
CTRL+8	Toggles the QuickCalc calculator palette
CTRL+9	Toggles the command window
CTRL+A	Selects objects in drawing
CTRL+SHIFT+A	Toggles Groups
CTRL+B	Toggles Snap
CTRL+C	Copies objects to Clipboard
CTRL+SHIFT+C	Copies objects to Clipboard with Base Point
CTRL+D	Toggles Dynamic UCS
CTRL+E	Cycles through isometric planes
CTRL+F	Toggles running object snaps
CTRL+G	Toggles Grid
CTRL+H	Toggles PICKSTYLE
CTRL+I	Toggles COORDS

9.6 LIMITS

Sets an invisible rectangular boundary in the drawing area that can limit the grid display and limit clicking or entering point locations. The following prompts are displayed.

Lower-Left Corner

Specifies the lower-left corner for the drawing limits.



Upper right corner

Specifies a point in the drawing area that represents the opposite corner of the rectangular limits boundary.

On

Turn on limits checking. When limits checking is on, you cannot enter points outside the grid limits. Because limits checking tests only points that you enter, portions of objects such as circles can extend outside the grid limits.

Off

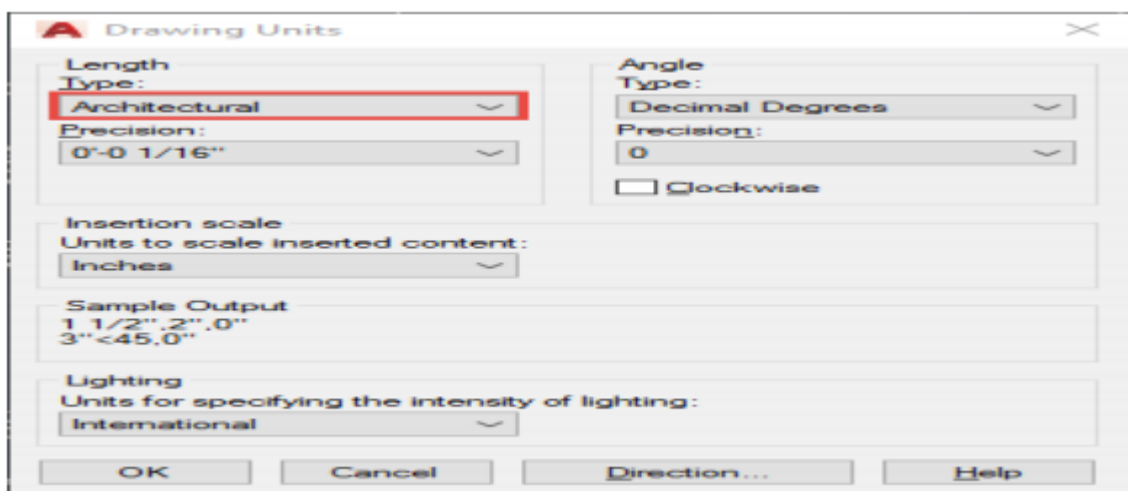
Turns off limits checking but maintains the current values for the next time you turn on limits checking.

9.7

UNITS

To change units in a drawing:

1. Type in **UNITS** on the command line.
2. Select Architectural under the first drop-down menu and then click OK



9.8.

DRAW COMMANDS

9.8.1. Line Command

Creates single straight line segments

1. Choose Draw Line.
2. Click the Line icon. or
3. Type **LINE** from the command prompt
Command : **LINE** or **L**

4. **Press** ENTER

5. **Pick** From point : **(point)**

9.8.

DRAW COMMANDS

9.8.1. Line Command

Creates single straight line segments

1. **Choose** Draw Line. **or**

2 click The Line icon. **or**

3. **Type** LINE from the command prompt Command : **LINE** or **L**

4. **Press** ENTER

5. **Pick** From point : **(point)**

6. **Pick** Specify next point or [Close / Undo] : **(point)**

7. **Pick** Specify next point or [Close / Undo] : **(point)**

8. **Press** ENTER to end line sequence **or**

9. **Type** U to undo the last segment To point : **U** (undo) **or**

10. **Type** C to create a closed polygon To point : **C** (close)

9.8.2 Circles

Circle Command

1. **Choose** Draw, Circle.

2. Click the Circle icon.

3. **Type** CIRCLE at the command prompt. Command: **CIRCLE**

4. **Type** One of the following options: 3P/2P/TTR/ <<center point>>:

5. **Pick** A center point.

6. **Type** A radius or diameter.

7. **Pick** A radius or diameter Diameter/ <<radius>>:

9.8.3

Arc Command

1. **Choose** Draw, Arc. **Click** the Arc icon. or
2. **Type** ARC at the command prompt Command: **ARC**
3. **Draw** One of the arcs.-

Except for 3 point arcs, arcs are drawn in a COUNTERCLOCKWISE direction.-

While in the arc command, press the right mouse button to select the following options for arcs:

9.8.4. Rectangle

1. **Choose** Draw Rectangle
2. **Click** the Rectangle icon.
3. **Type** Rectangle at the command prompt Command RECTANG
Chamfer/Elevation/Fillet/Thickness/Width/ <First corner>:
4. **Pick** First corner.
5. **Pick** Other corner or type coordinates

9.9. EDIT and MODIFY Commands

9.9.1 Editing Polylines

1. **Choose** *Modify, Polyline.* or
2. **Pick** The Pedit icon from the Modify II toolbar.
3. **Type** PEDIT at the command prompt Command: **PEDIT**
4. **Pick** Pick a polyline to edit Select Polyline: (**pick**)
5. **Type** One of the following options : Close / Join / Width / Edit vertex / Fit Curve / Spline / Curve / Decurve / Undo / exit

9.9.2.

PEDIT options

Close Closes open polyline segments

Join Connects polylines, lines, and arcs to existing polylines.

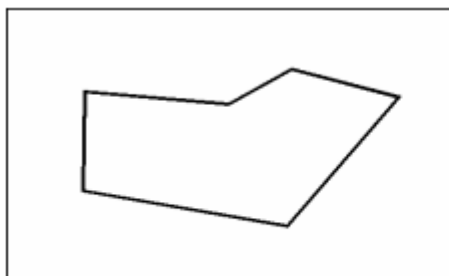
Width Changes the width for all polyline segments.

Fitcurve Creates curved arc segments around p line vertices at the direction you specify.

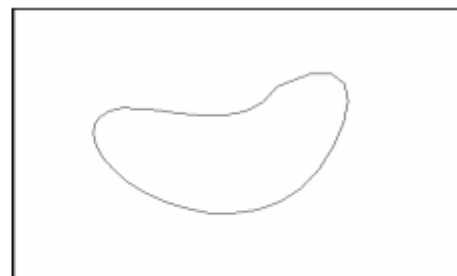
Spline Curve Creates a curve through control points on a polyline.

Decurve Straightens curved segments.

Edit Vertex Displays the following Edit Vertex Options:



Polyline width change



Splined Polyline

9.9.3

Move Command

1. **Choose** Modify, Move. or

2. **Click** The Move icon. or

3. **Type** MOVE at the command prompt Command : **MOVE** or **M**

4. **Pick** Objects to move Select objects : (**select**)

5. **Pick** A point to move from Base point or displacement : (**pick point**)

6. **Pick** A point to move to Second point of displacement : (**pick point**)



Circle before move



Circle after move

9.9.3. Copy Command

1. Choose Modify, Copy. or
2. Click the Copy icon. or
3. Type COPY at the command prompt. Command : **COPY** or **CP**
4. Pick Objects to copy. Select objects : (**select**)
5. Pick A point to move from. Base point or displacement/Multiple: (**pick point**).
6. Pick A point to copy to Second point of displacement: (**pick point**)
7. Type A point to copy to. Second point of displacement : **@**
1<0

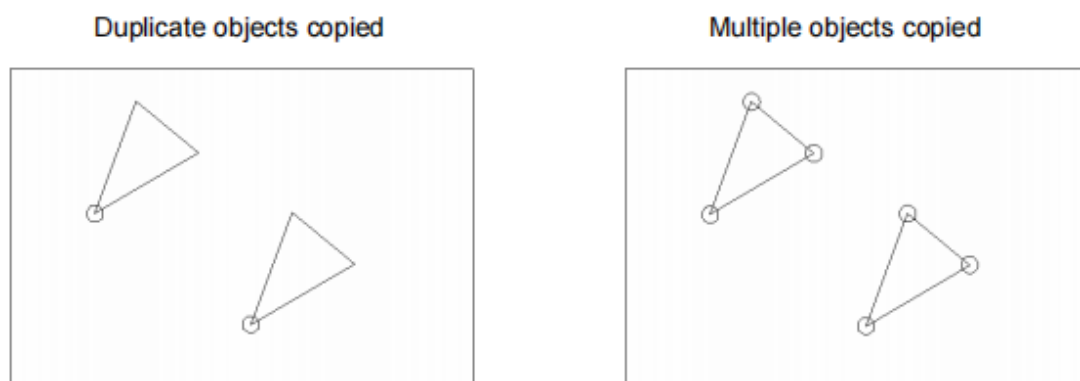


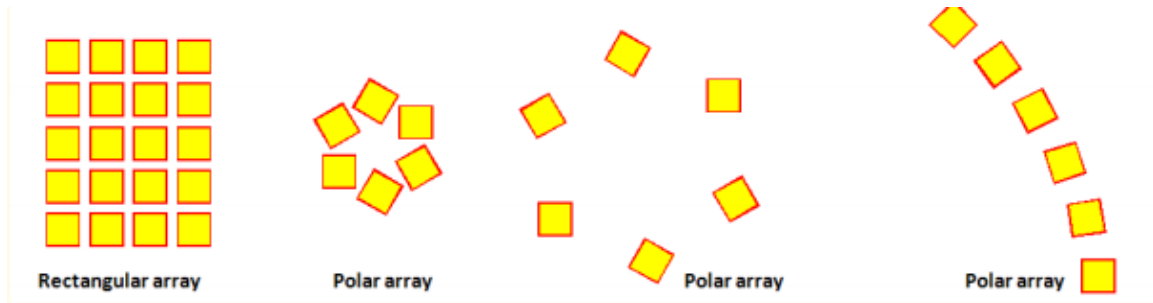
Fig 9.11

CREATING AND ARRAY OF OBJECTS

The array command in AutoCAD is used to make multiple copies of objects.

Although you can use the copy command to duplicate objects, the array command is more flexible and precise. One advantage of using the array command is that it allows you to copy objects in a defined angle and exact number of copies. Therefore, you can create array in various patterns. For

example, you can show multiple objects in a row, column, or irregular pattern such as a spiral. Let's look at a few examples below:



THANK YOU.....