Engineering Graphics

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Introduction of Drawing

- The art of represent an object on a piece of paper is drawing.
- Types of drawing:
- 1. Artistic drawing
- 2. Engineering drawing

Artistic Drawing

- The art of represent an object on a piece of paper by artistic is called artistic drawing.
- Artistic drawing is the creation of images based on imagination, emotions, visual expression, or creativity.
- Example: Portrait sketches
- Landscapes
- Cartoon drawings
- Creative illustrations

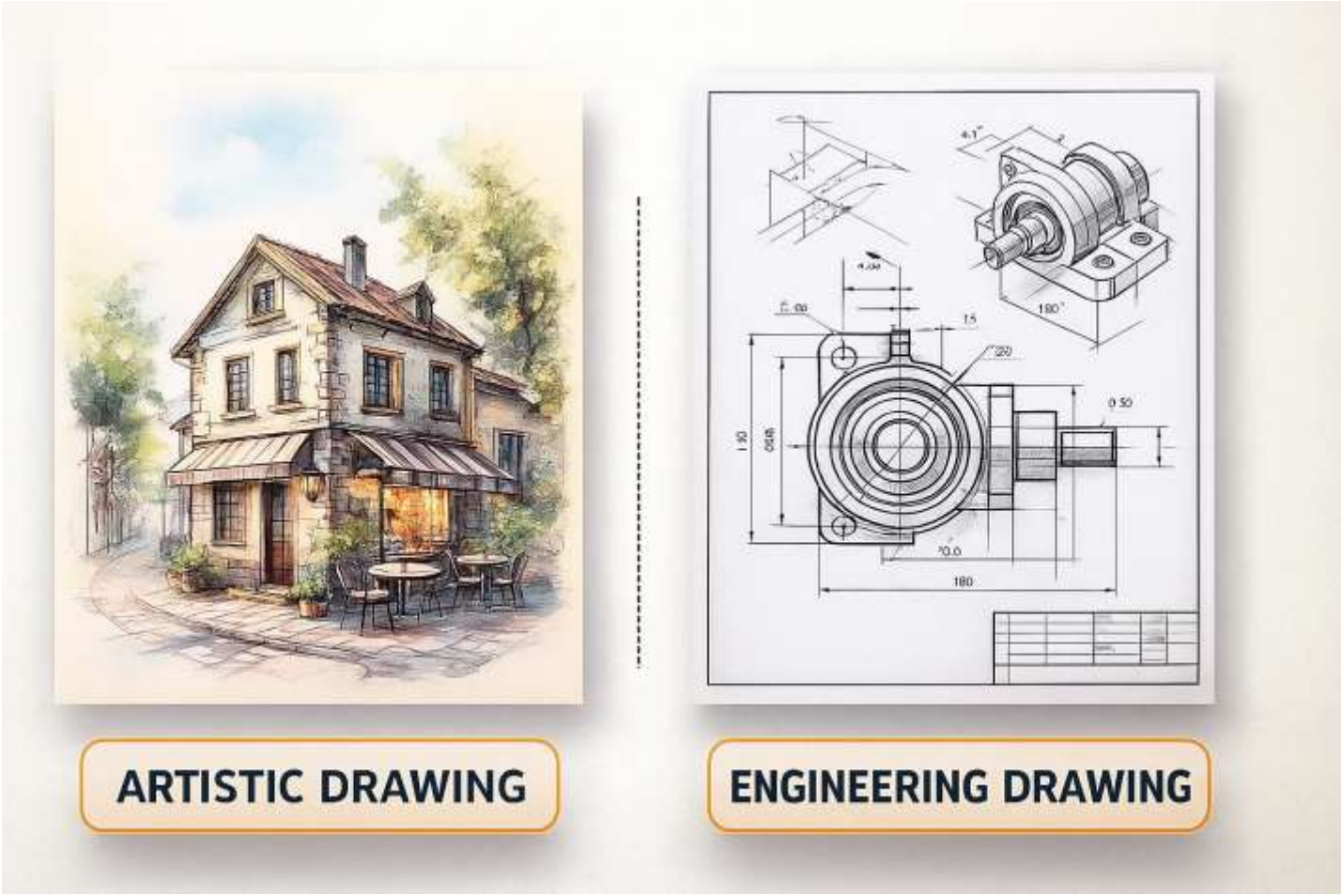
Engineering Drawing

- The graphical representation of engineering objects on a piece of paper is called engineering drawing.

  or

- The art of representation engineering object on a piece of paper by engineer is called engineering drawing.
- Example : Civil building plans etc.

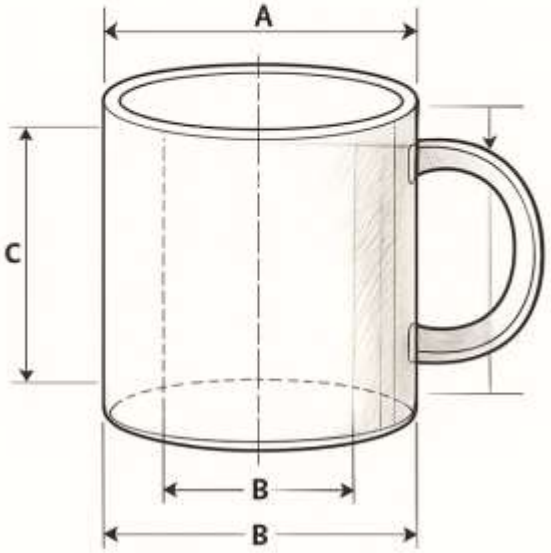
Example of Artistic Drawing & Engineering Drawing



Example of Artistic Drawing & Engineering Drawing

Artistic Drawing

Engineering Drawing



Types of Engineering Drawing

- 1. Geometrical Drawing:
- e.g. geometrical objects rectangle, square, cube, cone, cylinder, etc.
- A. Plain Geometrical Drawing:
- Two dimensional drawing having only length and breadth. e.g. square, triangle, etc.

Types of Engineering Drawing

- B. Solid Geometrical Drawing:
- Three dimensional drawing having length, breadth and thickness.
- e.g. cube, prism, etc.
- 2. Mechanical Engineering or Machine Drawing:
- e.g. mechanical engineering objects machines, machine parts, etc.

Types of Engineering Drawing

- 3. Civil Engineering Drawing:
- e.g. civil engineering objects - roads, buildings, bridges, dams, etc.
- 4. Electrical & Electronics Engineering Drawing:
- e.g. electrical and electronics objects - transformers, wiring diagrams.

Drawing instruments and other drawing materials:

Following is the list of instruments and other ancillary accessories required for construction of drawing.

- 1. Drawing board
- 2. T-square
- 3. Set-squares
- 4. Compass
- 5. Divider

Drawing instruments and other drawing materials:

- 6. Protractor
- 7. Scale
- 8. Pencil
- 9. Rubber pr eraser
- 10. Drawing clips/Drawing pins
- 11. Duster or handkerchief
- 12. Mini-drafter

Drawing board

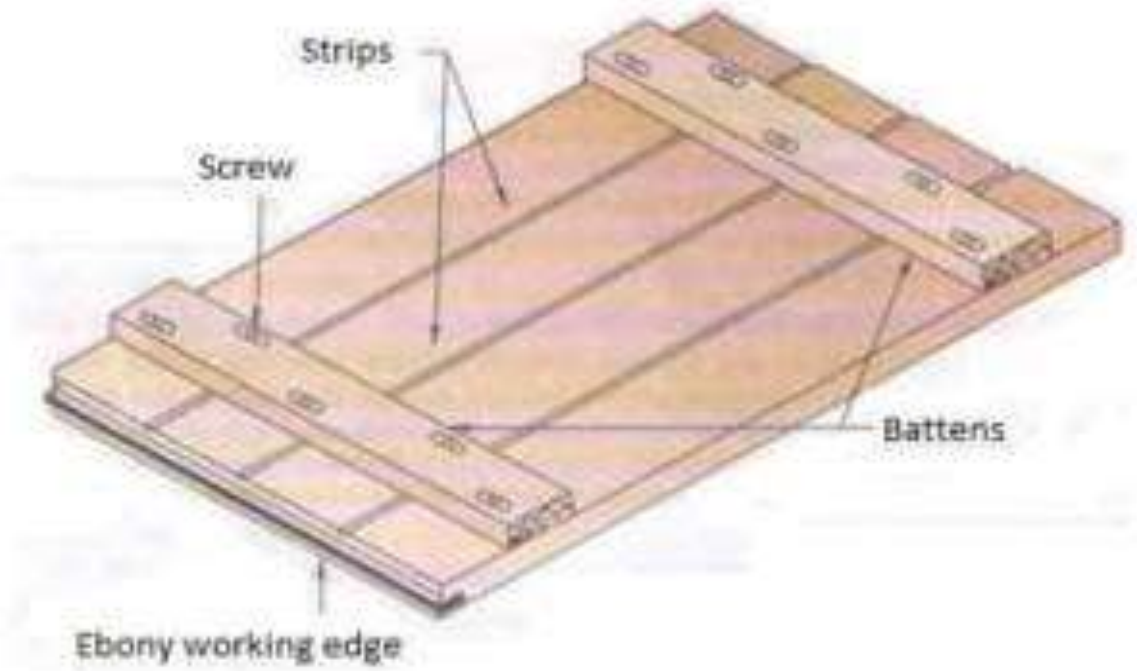


Figure 1: Drawing board

Drawing board

- A first class engineering drawing board is made of four to six strips of well seasoned soft good quality soft wood such as pine, fir, oak or kill of thickness about 18 mm.
- The wooden strips are cleated at the back by two battens by means of screws to prevent warping. One of the shorter edges of the rectangular board is fitted with a perfectly straight ebony strip.
- This edge is used as working edge for the T-square, which moves against the ebony edge.

Drawing board

Sl. No.	Designation	Size in mm (Length X width X thickness)	To be used with sheet sizes
1	D_0	1500x1000x25	A_0
2	D_1	100x700x25	A_1
3	D_2	700x500x15	A_2
4	D_3	500x350x15	A_3

Drawing Sheet

- Different qualities of drawing sheets are available in the market. Depending upon the nature of the drawing the qualities of drawing papers are selected. The drawing paper should be of uniform thickness and of such quality that erasing should not have leave any impression on it. One of the sides of the drawing paper is usually rough and the other smooth. The smooth surface is the side for the drawing work.

Drawing Sheet

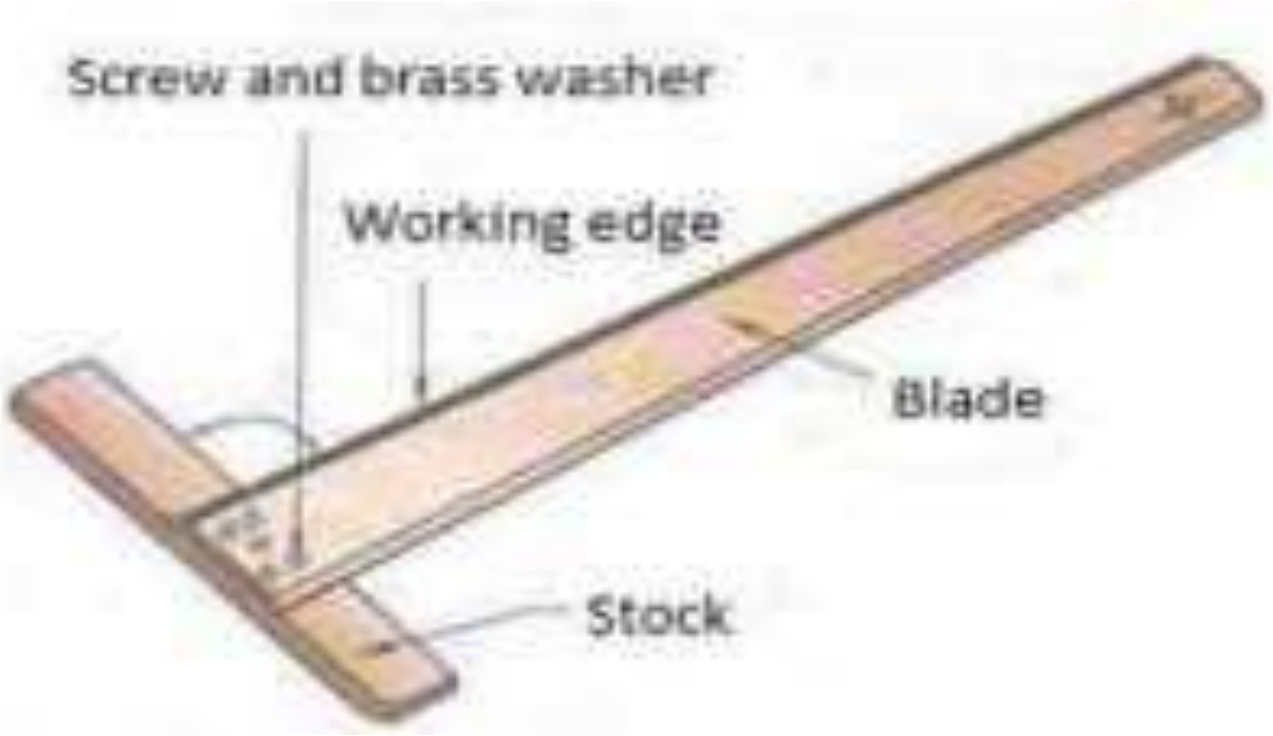
Table 2: Standard sizes of trimmed and untrimmed drawing sheets

Sl. No.	Designation size in mm	Trimmed size in mm (Width x Length)	Untrimmed size in mm Width x Length
1	A_0	841 x 1189	800 x 1230
2	A_1	594 x 841	625 x 880
3	A_2	420 x 594	450 x 625
4	A_3	297 x 420	330 x 450
5	A_4	210 x 297	240 x 330
6	A_5	148 x 210	165 x 240

T-square

- T-square is made of hard quality wood such as teak or mahogany, etc. These are two essential parts of T-square, namely stock and blade. The blade is fitted with an ebony or plastic piece to form working edge of T-square. The two parts are held securely together at right angles to each other by means of screws or dowel pins in order to form a straight edge of blade as shown in the Figure. The working length of the T-square is equal to the length of the drawing board.

T- Square



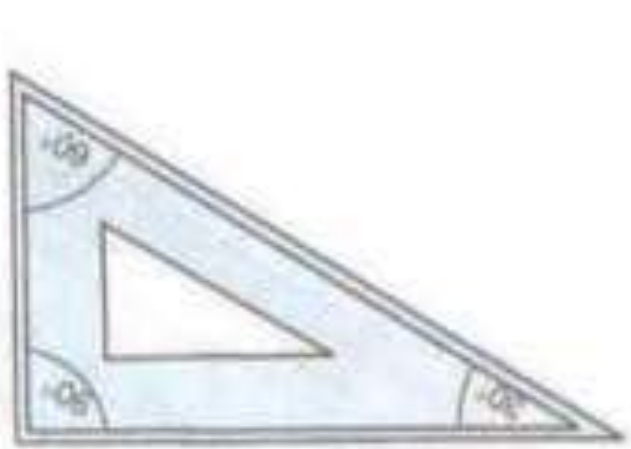
Set squares

- Set squares are triangular in shape and are made of celluloid or plastic materials. Set squares made of transparent celluloid are the most satisfactory ones as the lines underneath them can be seen quite easily. Generally two types of set squares are in use. There are: (i) thirty-Sixty degree (30^o - 60^o) set square and (ii) Forty five degrees (45^o) set square. The 30^o - 60^o set square has three angles with the measures of 30^o, 60^o and 90^o respectively. Similarly, the 45^o set square has three angles with the measures of 45^o, 45^o and 90^o respectively.

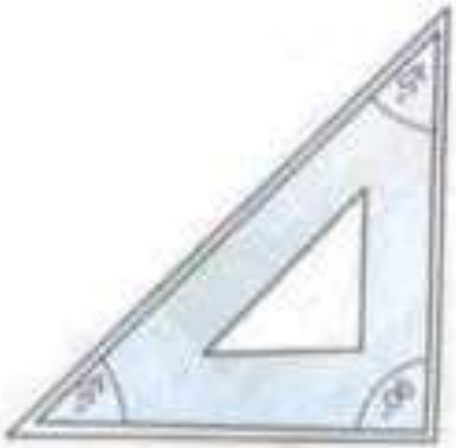
Set squares

- Set squares of different sizes are available in the market. Set squares are used for drawing all straight lines except the horizontal lines which are drawn with T-square or mini-drafter as the case may be.. Perpendicular lines or the lines at 30^{o}, 60^{o} and 90^{o} to the horizontal line can be drawn by using set squares.

Set squares



30^0 - 60^0 Set square



45^0 Set square

Compass

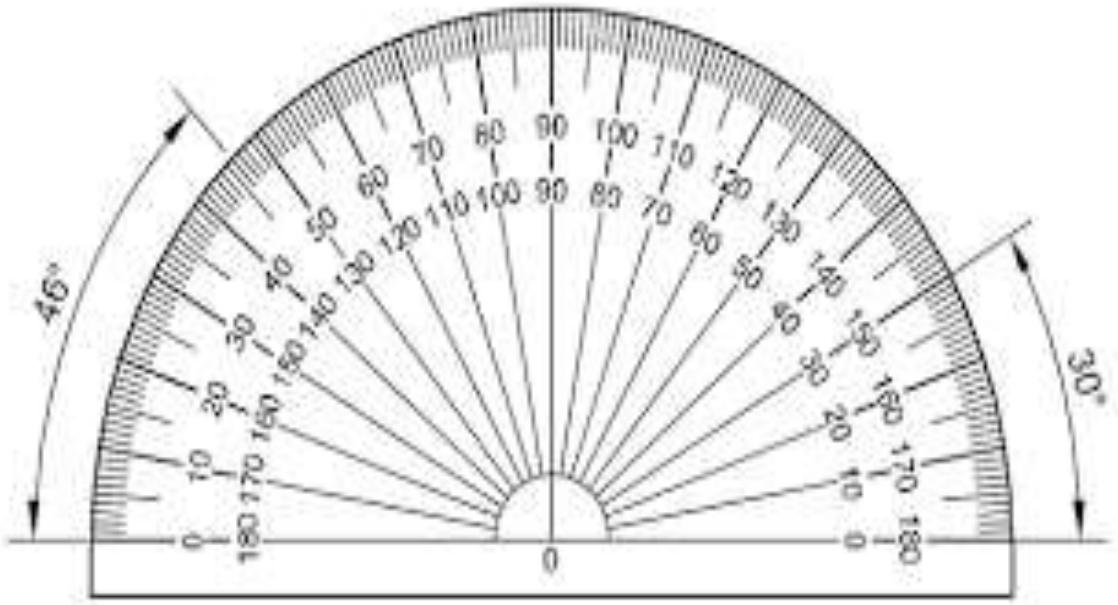
- Compass is used for drawing circles and arcs of circles of required diameter. It consists of two metal legs hinged together at its upper end by means of joint known as knee joint. An adjustable or fixed needle is fitted on to the end of one of the legs whereas the other leg is provided with an attachment which can be fitted with a pencil lid or pencil depending upon the nature of attachment. There are different types of compass available in the market depending upon their sizes, such as (i) large size compass and (ii) small size compass.

Compass

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 and angles of any measure between 0° to 180°. Least count of the protractor is generally 1^{o}.Like set square protractor is also made of transparent celluloid or plastic material.

Protractor



Scale

- Scales are used for measurement of lengths and distances on the drawing. Scale is a measuring stick, graduated on both its edges with different divisions to represent the corresponding actual distances of ground according to some fixed proportions. Such scales are known as RF scales or represent scales. Such scales facilitate rapid marking off distances on drawing.

Scale

- A suitable scale is always chosen to draw the drawings of big as well as small objects in proportionally smaller or larger sizes. Thus, scale can be expressed in the following three ways.
-
- ➤ Full size scale
-
- ➤ Reducing scale
-
- ➤Increasing scale

Full size scale:

- If actual dimension of an object is shown in the drawing then the scale used is said to be full size. scale.
- It can be represented as 1cm=1cm.

  1:1

Reducing scale

- If actual dimension of an object is reduced so as to accommodate that object in the drawing to be drawn on the provided drawing sheet, then the scale used is called reducing scale.
- This scale is represented as for example, 1cm-2m. This indicates that the linear dimension of 2m of an actual object is represented by 1cm in the drawing of that object.

  1:2, 1:50

Increasing or Enlarging scale

- When the drawings of very small objects are made larger than their actual dimension in the drawing sheet, the scale used is called increasing/enlarging scale.
- This scale is represented as for example, 1cm-2mm. This indicates that the linear dimension of 2mm of an actual object is represented by 1cm in the drawing of that object.
- 2:1, 10:1

Representative Fraction (R.F.)

- Representative Fraction (R.F.) is the ratio of drawing size of an object to its actual size.

- Formula = drawing size of an object/ actual size

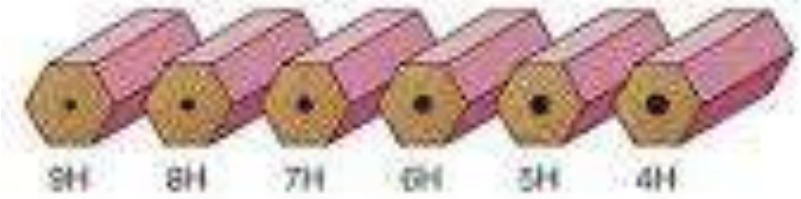
Pencils

- The pencils are used for preparing the drawings on the drawing sheet. The accuracy and the appearance of the drawing depend upon the quality of pencil used. Different grades of pencils are available depending upon the hardness of the lid. Pencils of various grades can be easily recognised by the letters marked on the body of the pencil..

Pencils

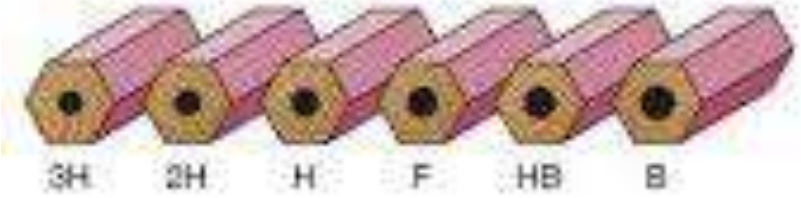
- The pencils are generally graded as H, F, B and HB. H represents hardness; F represents firm, B represents softness and HB represents intermediate between hard and soft. The general designation of a pencil is associated with alpha-numeric symbols such as 2H, 3H, HB, B, 2B, 3B, etc. Figure Xx shows various grades of pencils. Drawing pencils are graded as 7B, 6B, HB, H, 2H,... in the increasing order of their hardness and decreasing order of their blackness. Generally drawings are made with 2H pencils and finished with H or HB pencils.

Pencils



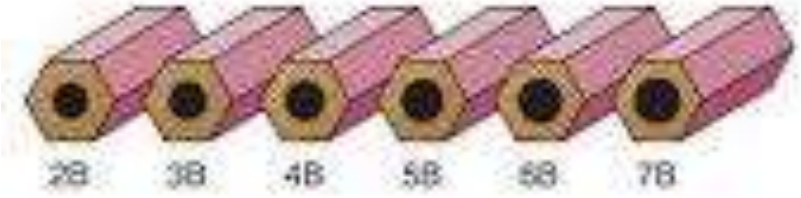
HARD

The hard leads are used for construction lines on technical drawings.



MEDIUM

The medium grades are used for general use on technical drawings. The harder grades are for instrument drawings and the softer for sketching.



SOFT

Soft leads are used for technical sketching and artwork but are too soft for instrument drawings.

Lines

Table 2.1 Convention of various types of lines according to BIS SP: 46 - 1988

	Continuous thick	Visible outlines Visible edges
	Continuous thin	Imaginary lines of intersection Dimension lines Projection lines Leader lines Hatching Short centre lines
	Continuous thin with zigzags	Long-break line
	Dashed thick	Hidden outlines Hidden edges
	Dashed thin	Hidden outlines Hidden edges
	Continuous thin freehand	Limits of partial or interrupted views and sections, if the limit is not a chain thin line
	Chain thick	Indications of lines or surfaces to which a special requirement applies
	Chain thin	Centre line Line of symmetry Trajectories
	Chain thin, thick at ends and change of direction	Cutting planes
	Chain thin double- dashed	Outlines of adjacent parts Centroidal lines Parts situated in front of the cutting plane

Lettering

- The art of writing letters such as alphabets and numbers etc. is known as lettering.

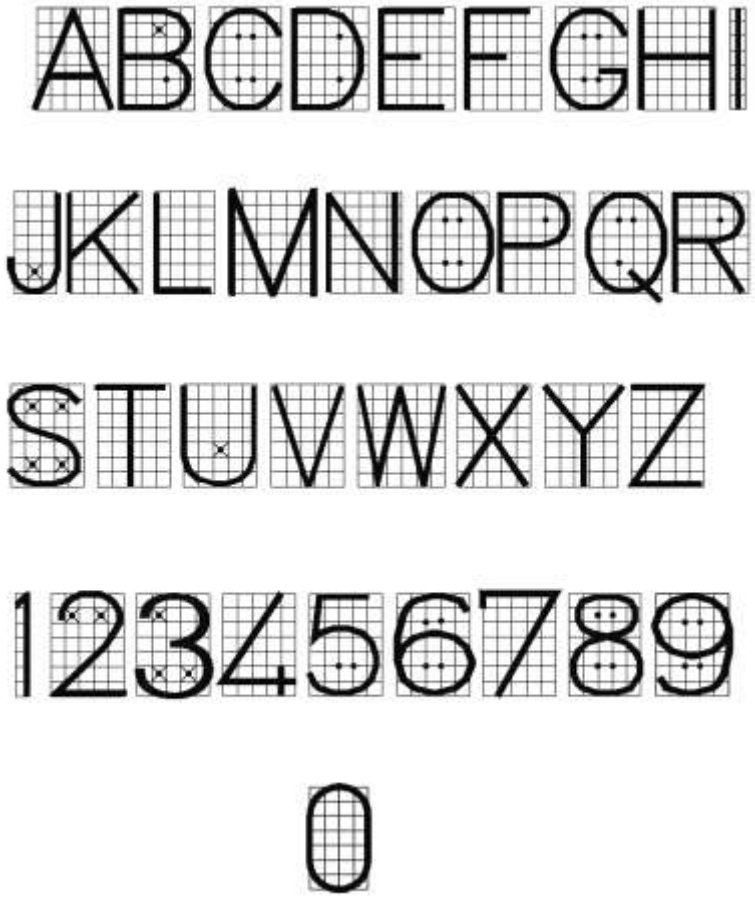
Types of Lettering:

- 1. Gothic Lettering
- 2. Roman Lettering
- 3. Free hand Lettering

Gothic Lettering

- Single stroke vertical gothic lettering
- Single stroke inclined gothic lettering
- Double stroke vertical gothic lettering
- Double stroke inclined gothic lettering
- Lower case vertical gothic lettering
- Lower case inclined gothic lettering

Single stroke vertical gothic lettering



Single stroke inclined gothic lettering

Dimensioning

- The art of writing the various sizes or measurements on the finished drawing of an object is known as dimensioning.
- The following two types of dimensions are commonly used in engineering drawing:
- 1. Size Dimensions.
- 2. Location Dimensions.

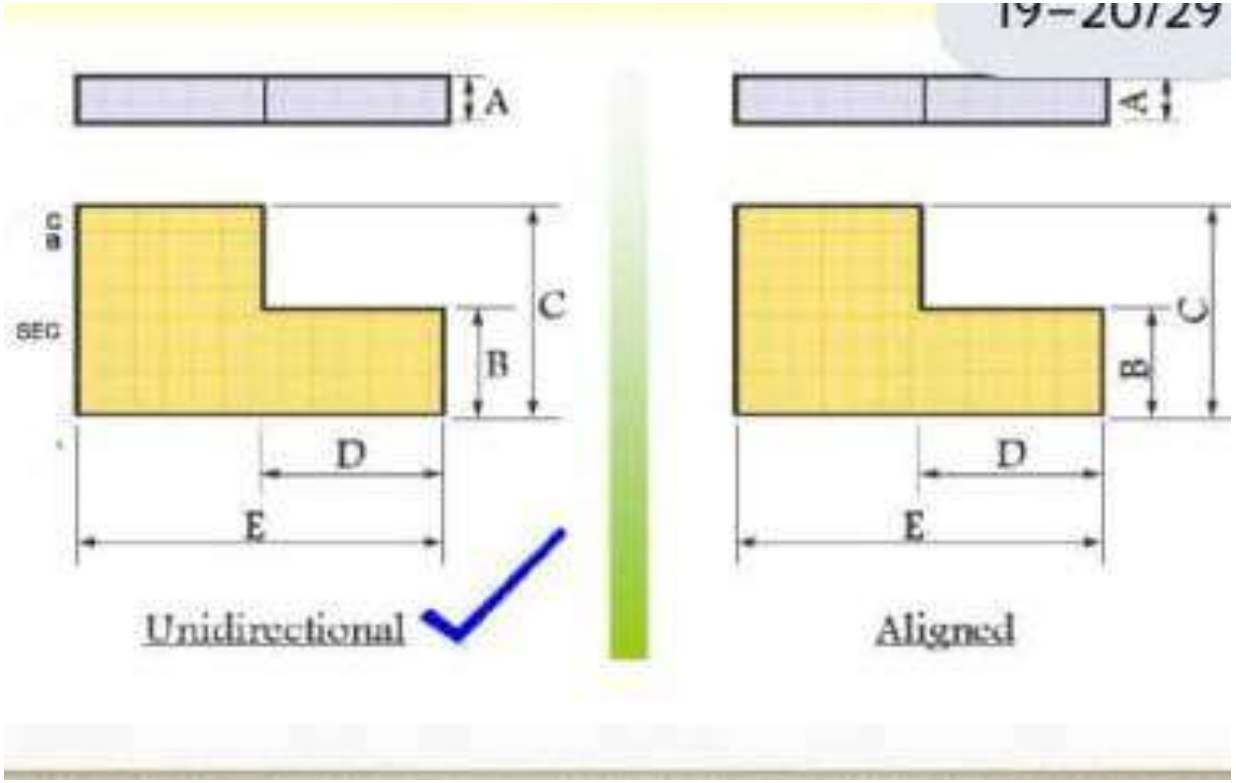
Types of dimensions

- Size Dimensions:
- The dimensions which indicate the various sizes of the object such as length, breadth, diameter, etc. are known as size dimensions.
- Location Dimensions:
- The dimensions which locate the position of one feature with respect to the other feature are known as location dimensions. Distances between the centre lines of the holes from the edges of features are given by location dimensions.

System of Placing Dimensions

- Aligned System: In this system, all dimensions are so placed that they may be read from the bottom or the right hand edges of the drawing sheet. Here all the dimensions are placed normal and above the dimensions lines (Latest Method).
- Unidirectional System: In this system, all dimensions are so placed that they may be read from bottom edge of the drawing sheet. Note, there is no restriction on the controlling the direction of the dimension lines.

System of Placing Dimensions



Geometric Construction

Methods of construction of parabola

- Rectangle method
- Tangent method

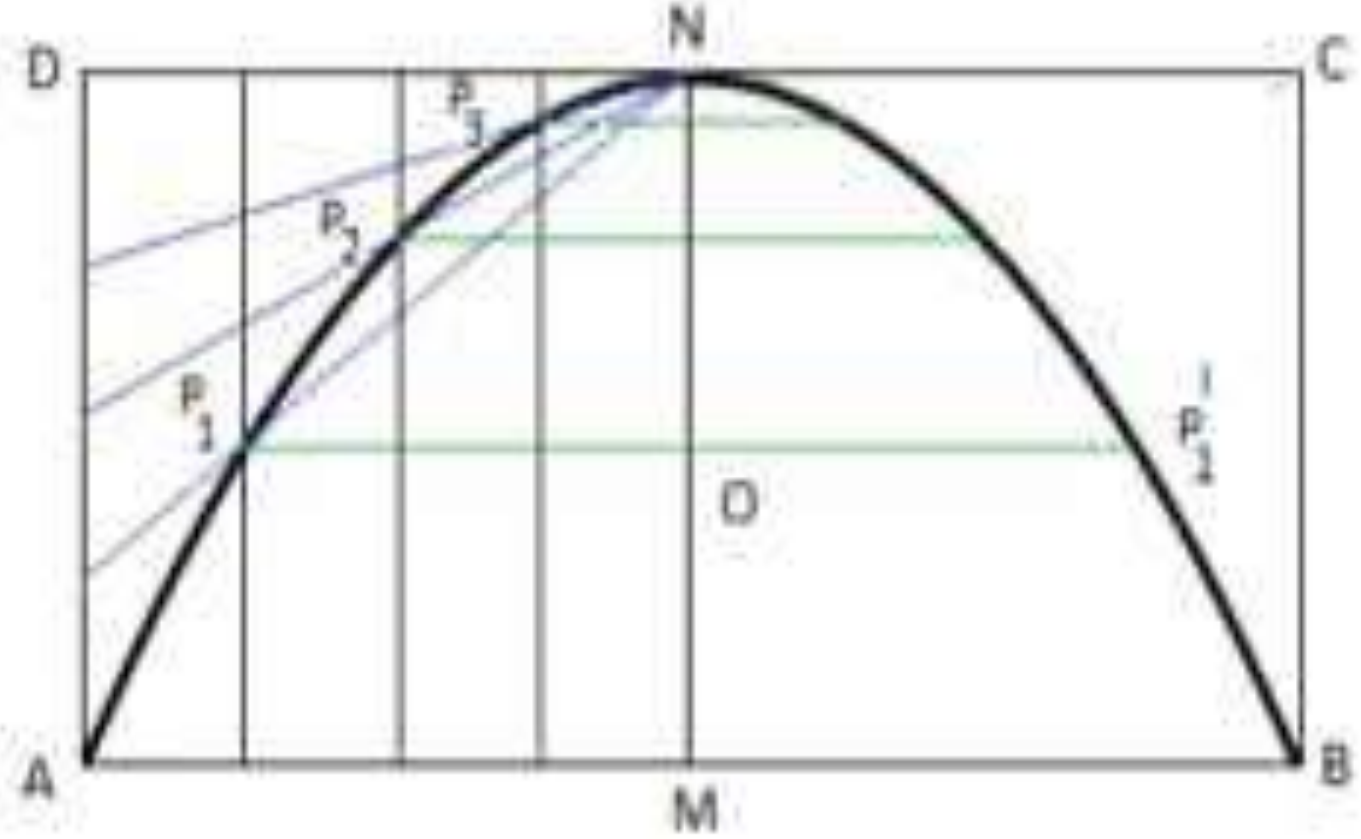
Rectangle method

- This method is used when the base and the axis are given.
- a. Draw a line AB as the base and mark the midpoint M on it.
- b. Through M, draw the axis MN at right angles to AB.
- c. Draw a rectangle ABCD with side BC equal to MN.

Rectangle method

- d. Divide AM and AD into same number of equal parts and name them as shown Draw lines joining N with 1, 2 and 3.
- e. Through 1', 2' and 3', draw perpendiculars to AB so as to intersect F1, F2 and F3 at points P_{1} P_{2} and P_{3} respectively.
- f. Draw a smooth curve through these points. The curve thus obtained is the required parabola.

Rectangle method



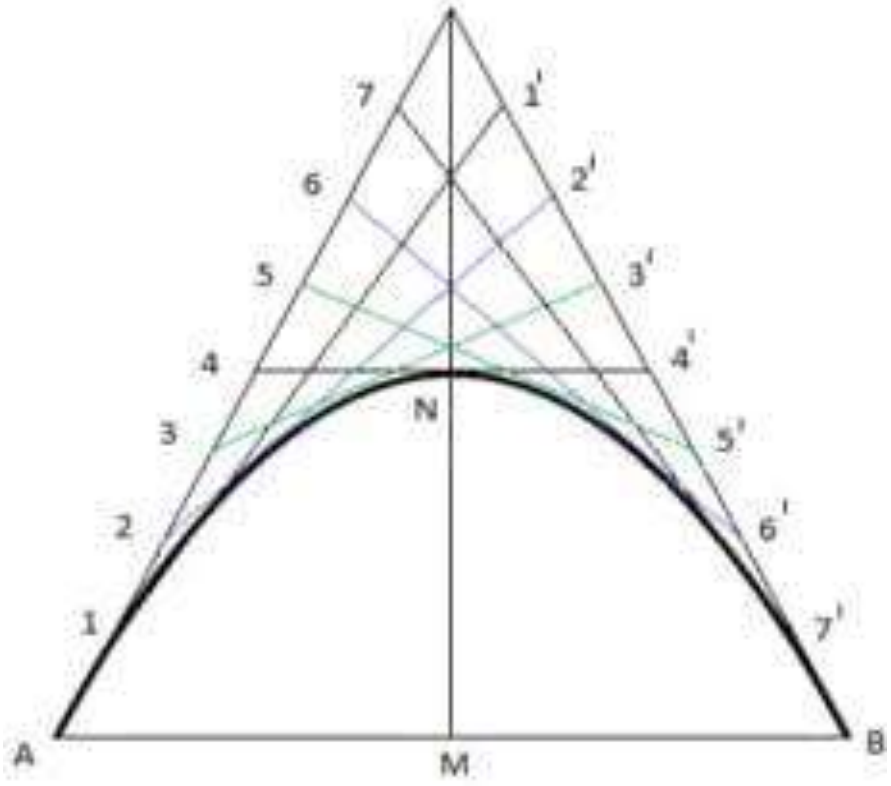
Tangent method

- This method is also used when the base and the axis are given.
- a. Draw a line AB as the base and mark the midpoint M on it.
- b. Through M, draw the axis MN at right angles to AB.
- c. Produce MN to O so that MN = NO

Tangent method

- d. Join O with A and B. Divide lines OA and OB into the same number of equal parts (say 7 or eight). More the number of parts better would be the parabola.
- e. Mark the division points as shown in the figure.
- f. Draw lines joining 11', 22', 33' and so on.
- g. Draw a smooth curve starting from A and tangential to these lines. The curve so obtained is the required parabola.

Tangent method



Geometric Construction

Methods of construction of ellipse

- Arc of circle method
- Concentric circle method

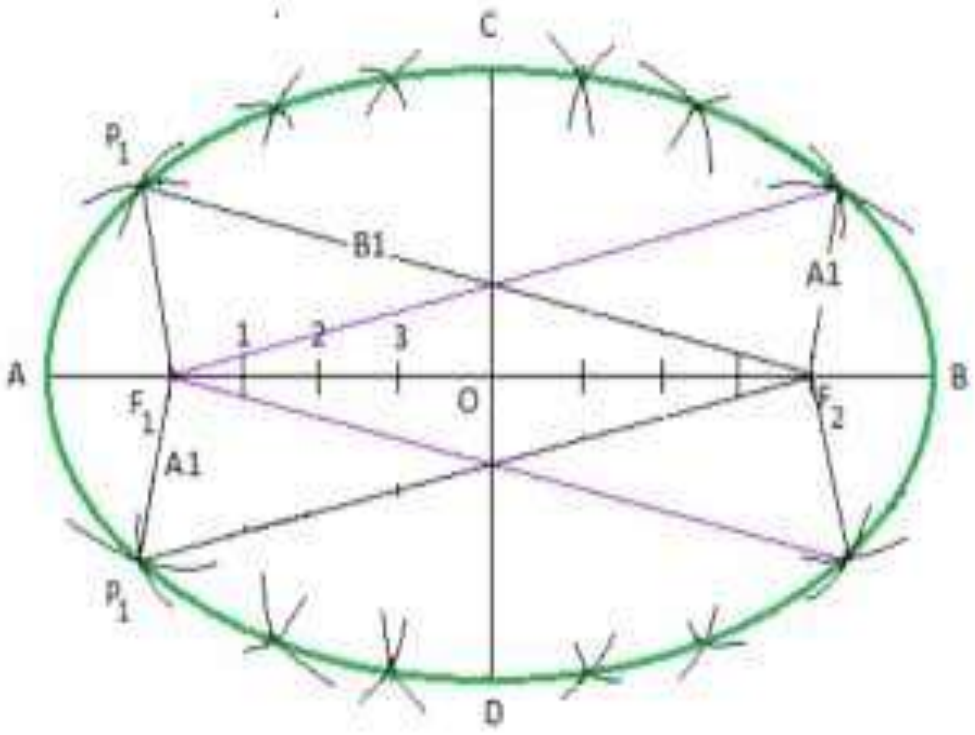
Arc of circle method

- This method is also used when the lengths of major and minor axes of an ellipse are given.
- a. Draw the major axis and minor axes as AB and CD respectively so as to intersect each other at right angles at O as shown in the figure.
- b. Draw two arcs with C as centre and radius equal to AO (semi-major axis half of AB) so as to cut major axis AB at F, and F. F and F_1 are the foci of the ellipse.
- c. Mark a number of points 1, 2, 3 etc. on AB.

Arc of circle method

- d. With F and F, as centres and Al as radius, draw arcs on both sides of AB.
- e. With same centres and radius equal to B1, draw arcs intersecting the previous arcs at four points marked as P.
- f. Similar points are obtained with radii A2 and B2; and A3 and B3 etc.
- g. Draw a smooth curve through all these points. The curve, so obtained, is the required ellipse

Arc of circle method



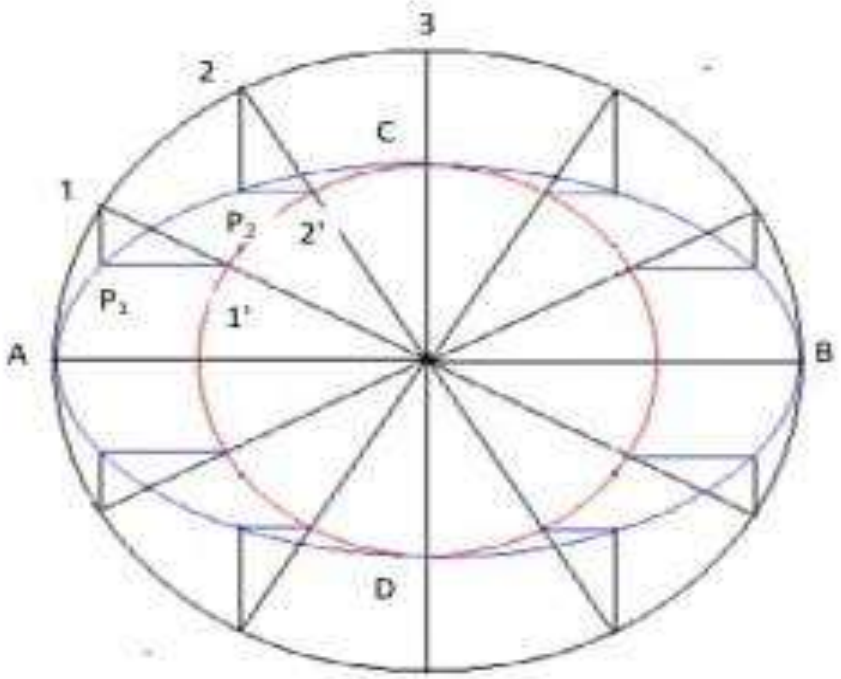
Concentric circle method

- This method is used when the lengths of major and minor axes of an ellipse are given.
- Procedure of construction
- a. Draw the major axis and minor axes as AB and CD respectively so as to inte angles at O as shown in the figure.
- b. With centre O and AB and CD as diameters draw two circles.
- c. Divide the circle described on the major axis (major-axis-circle) into a number of equal divisions, say 12 and mark 1,2 etc as shown.

Concentric circle method

- d. Draw lines joining these points with the centre O and cutting the circle described on the minor axis (manor-axis-circle) at points 1',2' etc.
- e. Through point 1 on the major-axis-circle, draw a line parallel to CD, the minor axis.
- f. Through point 1' on the minor-axis-circle, draw a line parallel to AB, the major axis.
- g. Mark the point of intersection of the above two parallel lines as P. The point P, thus obtained, is a point on the required ellipse.
- h. Repeat the construction through all the points and get more points.

Concentric circle method



Projection

- The shadow of an object on a piece of paper is called projection.
- Types of Projection:
- 1. Pictorial Projection
- 2. Orthographic Projection

Pictorial Projection

- 1. Perspective Projection
- 2. Isometric Projection
- 3. Oblique Projection

Perspective Projection

- The projection of an object on the picture plane and all the projections pass through the picture plane and meet at a single **point**, it is called **perspective projection**.
  In this projection, the object appears **smaller**, and the picture plane is considered **transparent**.

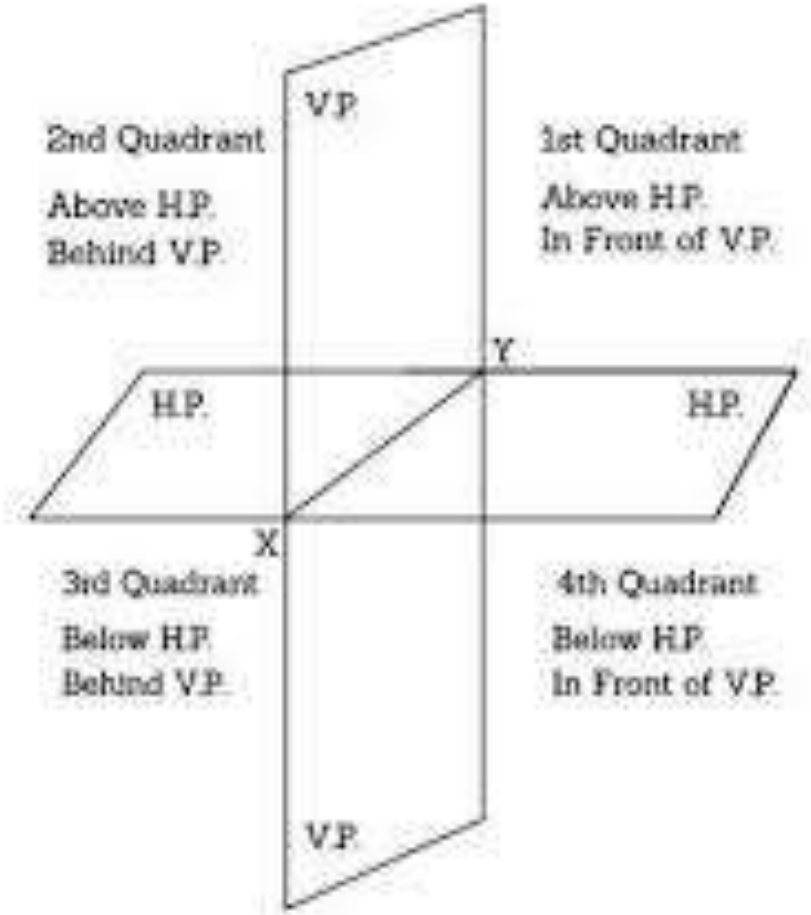
Isometric Projection

- The projection of an object on the picture plane, and all the projections are parallel to each other and inclined at an angle of **30 degrees** to the picture plane, it is called **isometric projection**.
  In isometric projection, the **three edges** (axes) and all the lines are parallel to one another.
  The **same scale** is used for constructing an isometric projection.

Oblique Projection

- The projection of an object on the picture plane, and all the projections are parallel to each other and inclined at an angle of **45 degrees** to the picture plane, it is called **Oblique Projection.**
  In isometric projection, the **three edges** (axes) and all the lines are parallel to one another. The **same scale** is used for constructing an isometric projection.

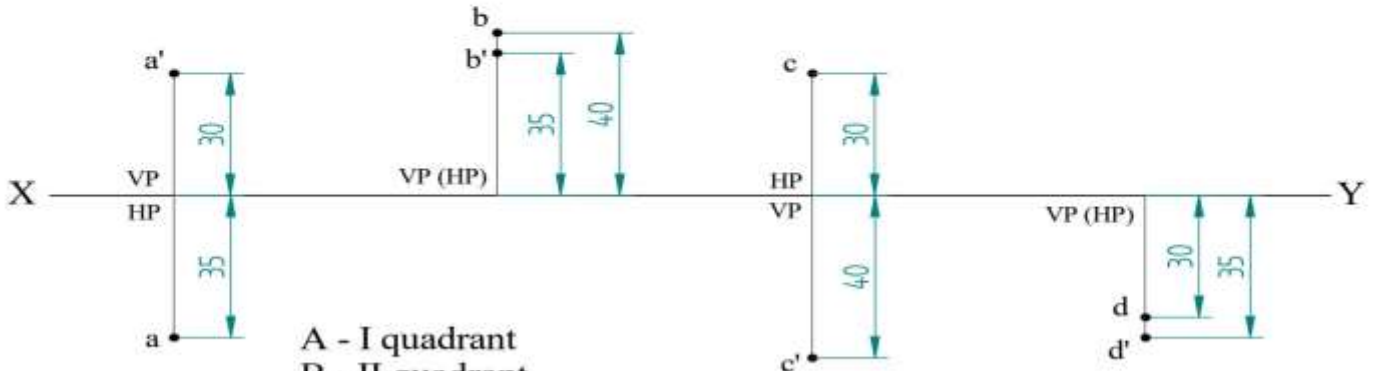
Projection Quadrants



Projection Quadrants

1) Draw the projections of the following Points on the same XY line, keeping convenient distance between each projectors. Name the quadrants in which they lie.

A - 30mm above HP and 35mm infront of VP.
B - 35mm above HP and 40mm behind VP.
C - 40mm below HP and 30mm behind VP.
D - 35mm below HP and 30mm infront of VP.



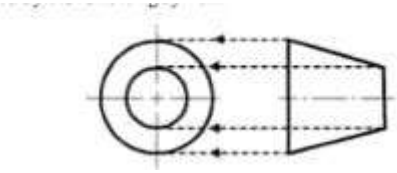
A - I quadrant
B - II quadrant
C - III quadrant
D - IV quadrant

First Angle Method

- 1. The object lies In between the observer and the plane of projection. The plane of projection Is always behind the object.
- 2. The object is assumed to be placed in first quadrant
- 3. The front view or the elevation Is always above the top view or the plan.

First Angle Method

- 4. The right hand end view/side view Is drawn to the left and left hand end view Is drawn to the right.
- 5. The plane of projection may or may not be transparent
- 6. It Is represented by the following symbol.

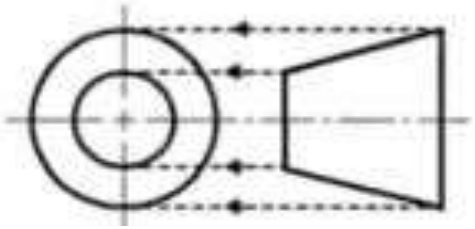


Third Angle Method

- 1. Between the observer and the object ore transparent planes of projection. The plane of projection Is always In front of the object.
- 2. The projections are drawn assuming that object Is situated In third quadrant
- 3. The front view Is always below the top view.

Third Angle Method

- 4. The right hand end view is drawn to the right and left hand end view Is drawn to the left.
- 5. The plane of projection Is always transparent.
- 6. It Is represented by the following symbol:



Projection of Point

What is point?

An element which has no dimensions, it can be situated in the following positions with respect to principal planes of the projections.

- Point situated above H.P and in front of V.P.
- Point situated above H.P and behind V.P
- Point situated below H.P and behind V.P.
- Point situated below H.P and in front of V.P.
- Point situated on H.P and in front of V.P.
- Point situated above H.P and on V.P.
- Point situated on H.P and behind V.P.
- Point situated below H.P and on V.P.
- Point situated on both H.P and V.P.

Projection of Point

- **First Quadrant:** Above HP, In front of VP (Standard position).
  - **Views:** Front View (a') is **above** XY; Top View (a) is **below** XY (HP rotates down).
- **Second Quadrant:** Above HP, Behind VP (HP & VP are transparent).
  - **Views:** Both a' and a are **above** XY (HP rotates up, overlaps VP).
- **Third Quadrant:** Below HP, Behind VP (HP & VP are transparent).
  - **Views:** Front View (a') is **below** XY; Top View (a) is **above** XY (HP rotates up).
- **Fourth Quadrant:** Below HP, In front of VP (Standard position).
  - **Views:** Both a' and a are **below** XY (HP rotates down, overlaps VP).

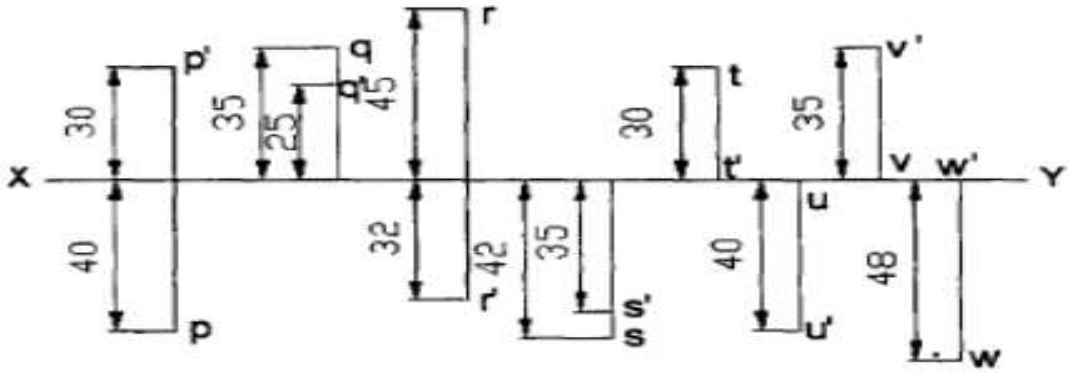
Projection of Point

Problem:

- ***Draw the orthographic projections of the following points?***

  (a.) Point P is 30 mm. above H.P and 40 mm. in front of VP
  (b.) Point Q is 25 mm. above H.P and 35 mm. behind VP
  (c.) Point R is 32 mm. below H.P and 45 mm behind VP
  (d.) Point Sis 35 mm. below H.P and 42 mm in front of VP
  (e.) Point T is in H.P and 30 mm behind VP
  (f.) Point U is in V.P and 40 mm. below HP
  (g.) Point V is in V.P and 35 mm. above H.P
  (h.) Point W is in H.P and 48 mm. in front of VP

Solution:

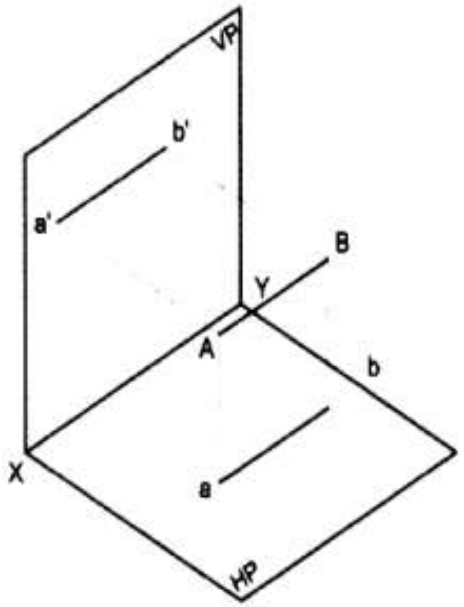


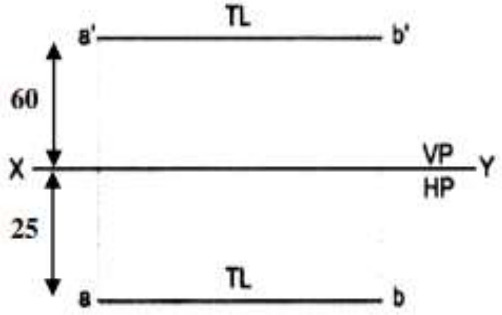
PROJECTION OF STAIGHT LINES

- **What is Line?**
- A Shortest distance between two points and the actual length of the line is known as True Length denoted by TL.
- Orientation of Straight Lines
- Line parallel to both H.P and V.P
- Line perpendicular to H.P and parallel to V.P
- Line perpendicular to V.P and parallel to H.P
- Line inclined to H.P and parallel to V.P
- Line inclined to V.P and parallel to H.P
- Line situated in H.P Line situated in V.P
- Line situated in both H.P and V.P
- Line inclined to both the reference planes.
    1. Line inclined to both H.P and V.P front view angle and top view angle =90º
    2. Line inclined to both H.P and V.P front view angle and top view angle =90º

Line parallel to both H.P and V.P

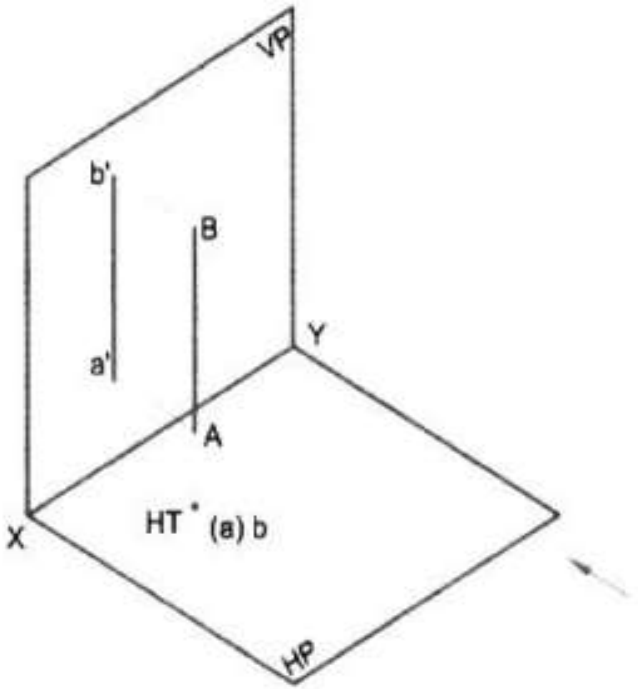
- A 50mm long line AB is parallel to both H.P and V.P. The line is 25mm in front of V.P and 60mm above H.P, draw the projections of the line.

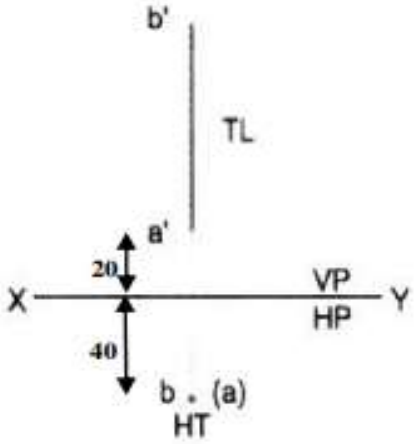




Line perpendicular to H.P

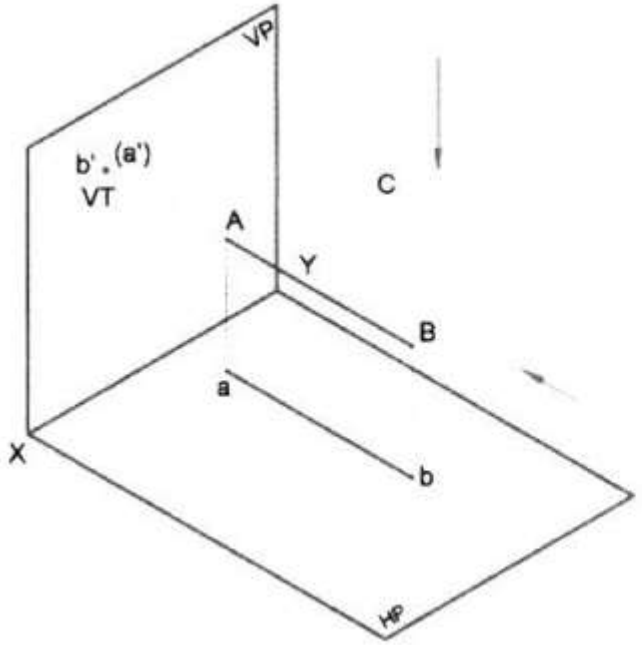
- A 60mm long line AB has its end A at a distance of 20mm above the H.P. The line is perpendicular to the H.P and 40mm in front of V.P, draw the projections of the line.

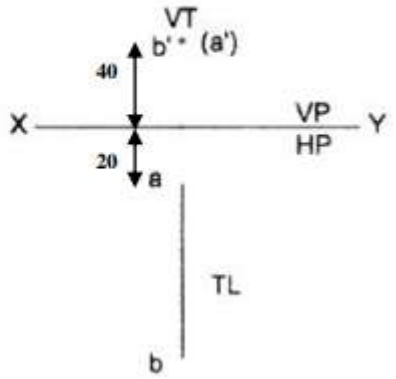




Line perpendicular to V.P

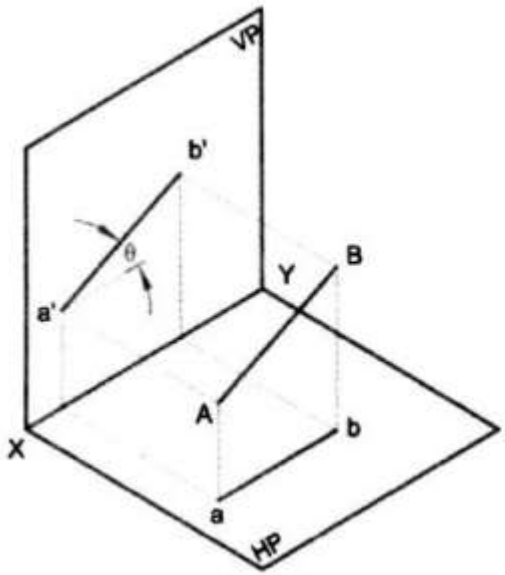
- A 60mm long line AB, has its end A at a distance of 20mm in front of the V.P. the line is perpendicular to V.P and 40mm above H.P, draw the projection of the line.

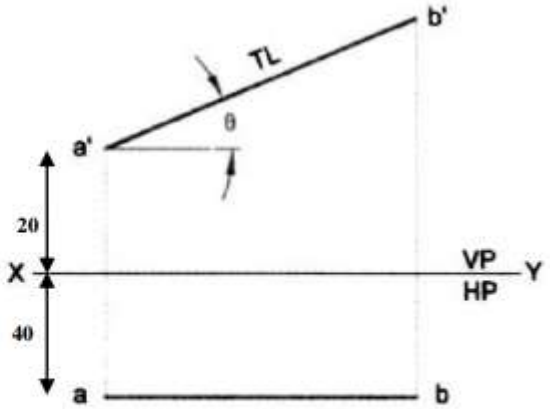




Line inclined to H.P and parallel to V.P

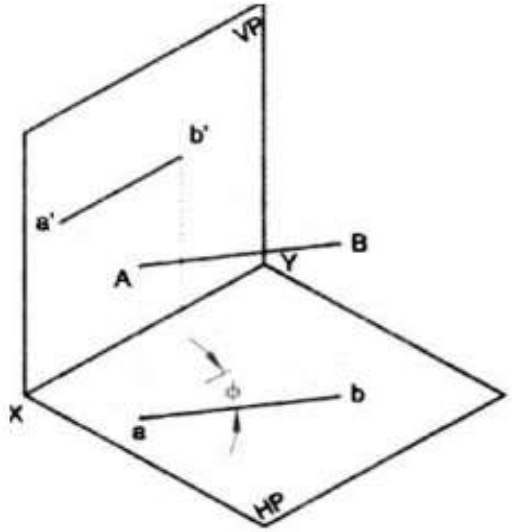
- A 80mm long line AB has the end A at a distance of 20mm above HP and 40mm in front of V.P. The line is inclined at 30 deg to H.P and parallel to V.P, draw the projection of the line.

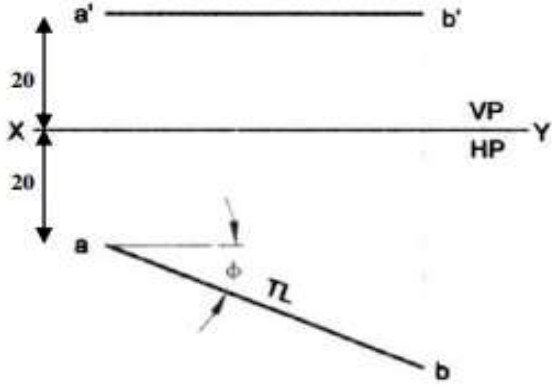




Line inclined to V.P and parallel to H.P

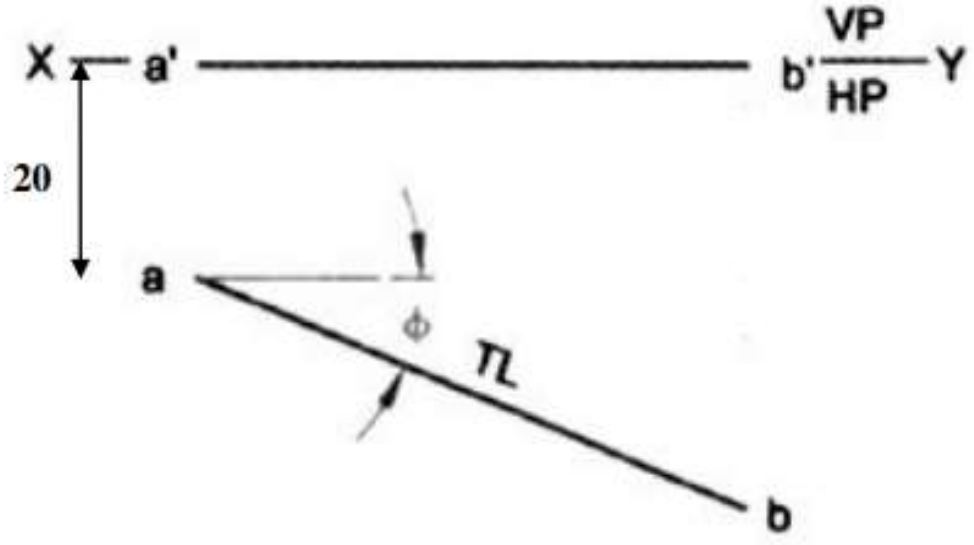
- An 80mm long line AB is inclined at 30 deg to V.P and is parallel to H.P. The end A is 20mm above the H.P and 20mm in front of the V.P, draw the projection of the line.





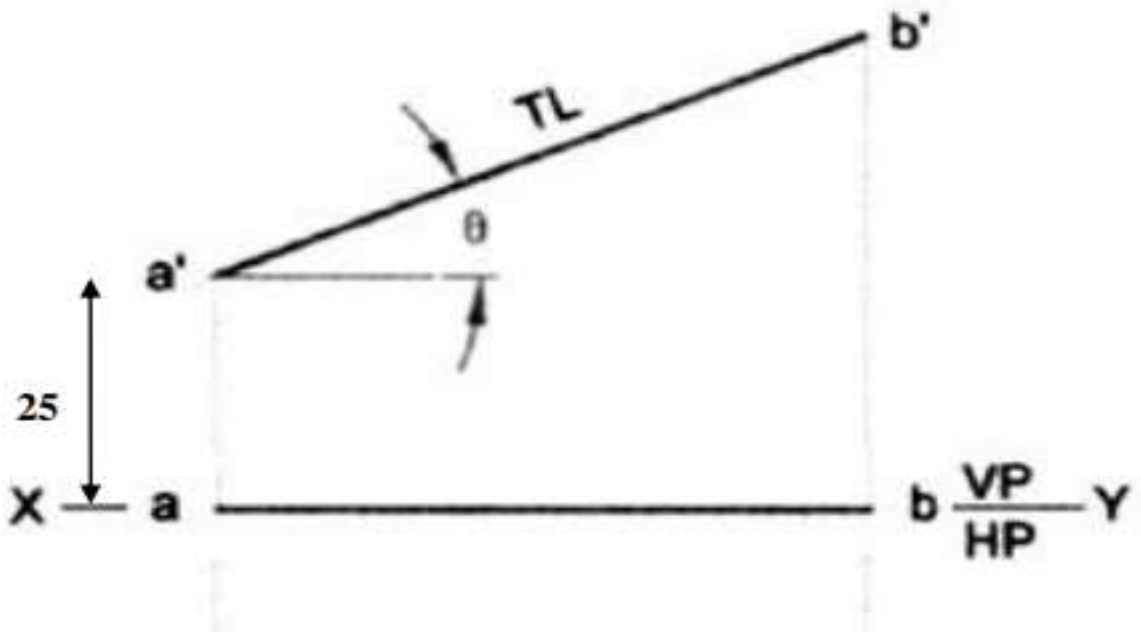
Line situated in H.P

- A line AB 60mm long is situated in H.P and inclined to V.P at 30 deg. The end A is 20mm in front of V.P, draw the projection of line.



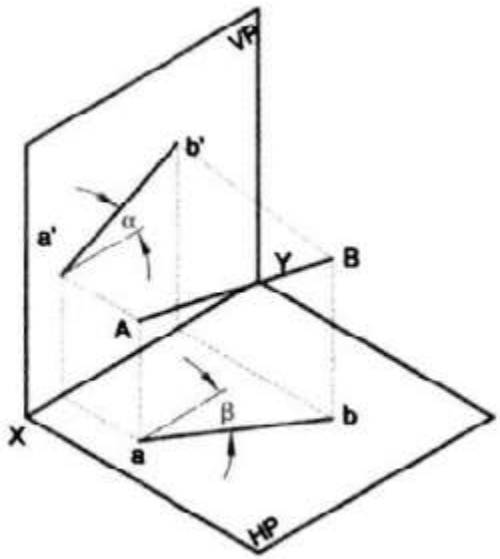
Line situated in V.P

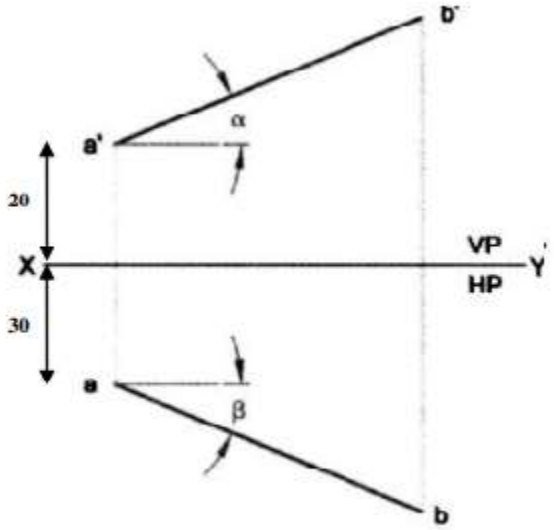
- Draw the projections of 70mm long line AB situated in the V.P and inclined at 30 deg to H.P. The end A is 25 mm above H.P.



Lines inclined to both the reference planes

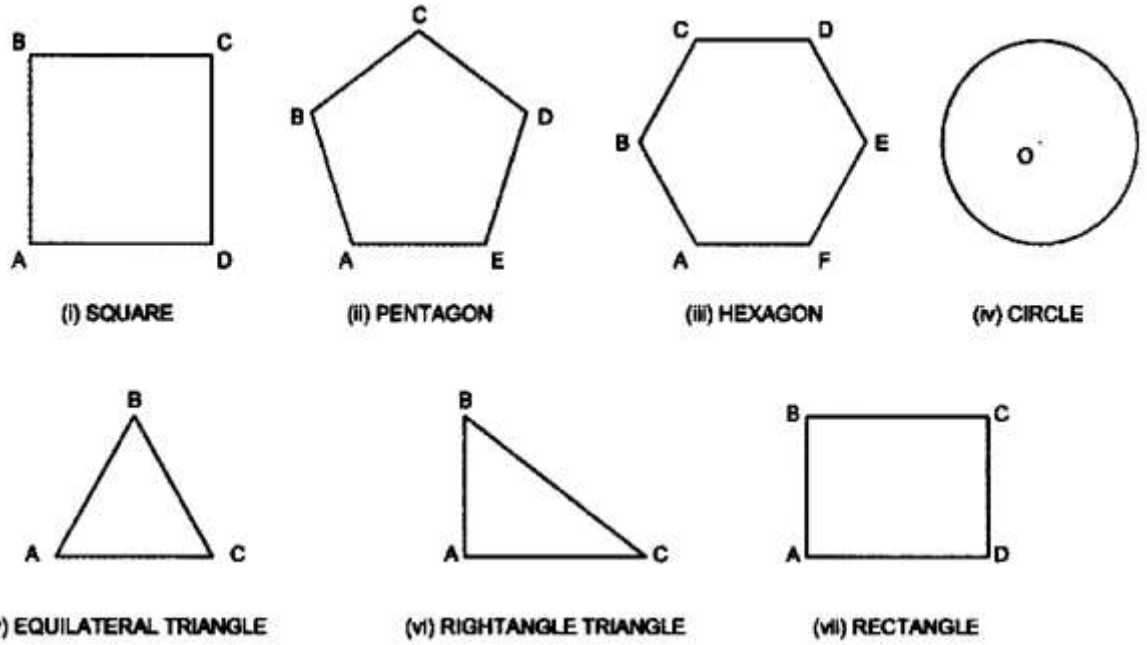
- A 70mm long line AB has an end A at 20mm above H.P and 30mm in front of V.P. The line is inclined at 45 deg to the H.P and 30 deg to V.P, draw the projections.





PROJECTION OF PLANES

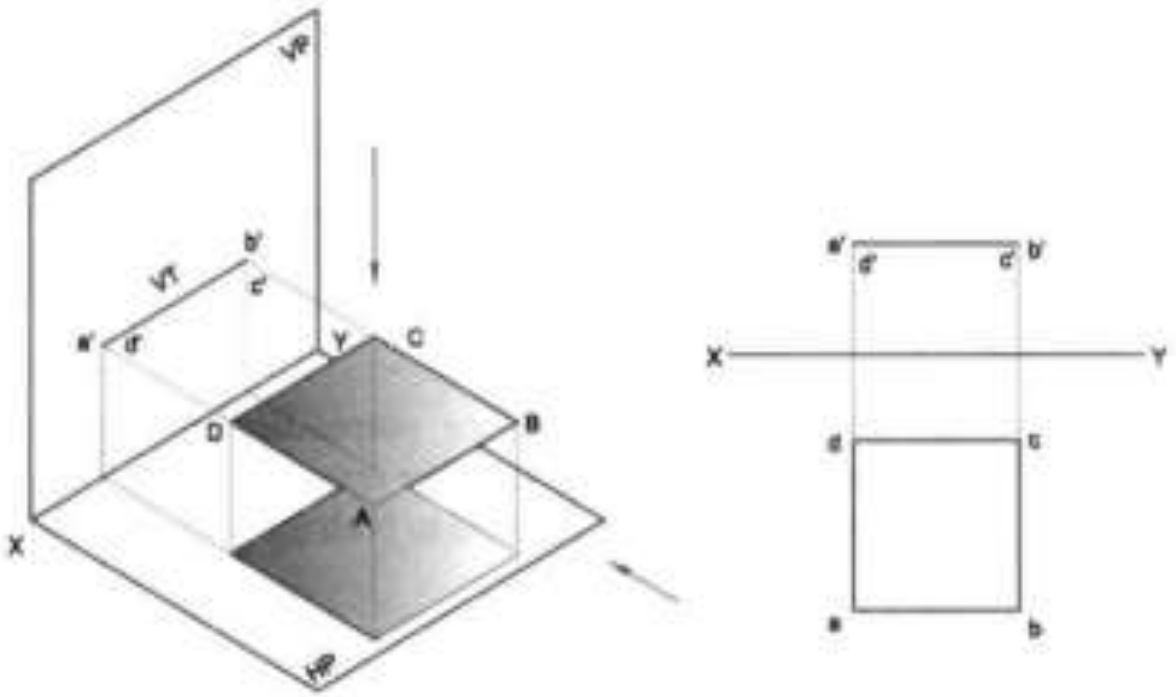
- A plane is a two dimensional object having length and breadth only. Its thickness is always neglected; various shapes of plane figures are considered such as square, rectangle, circle, pentagon, hexagon, etc



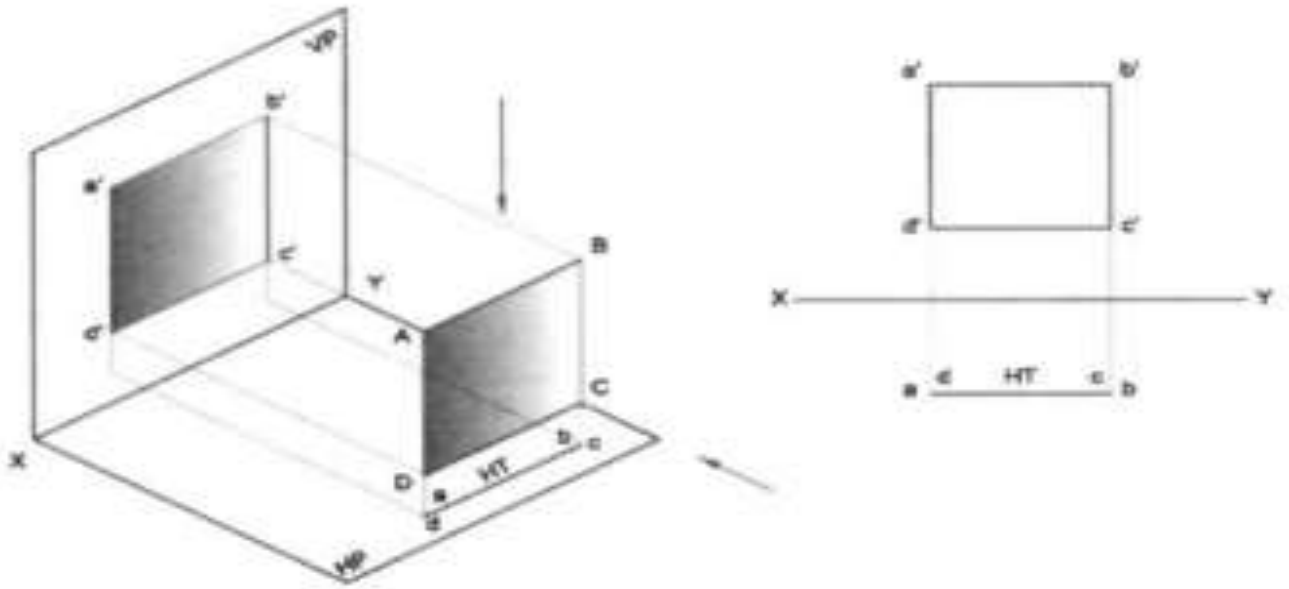
PROJECTION OF PLANES

- TYPES OF PLANES:
- 1. Perpendicular planes which have their surface perpendicular to anyone 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.
- 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.

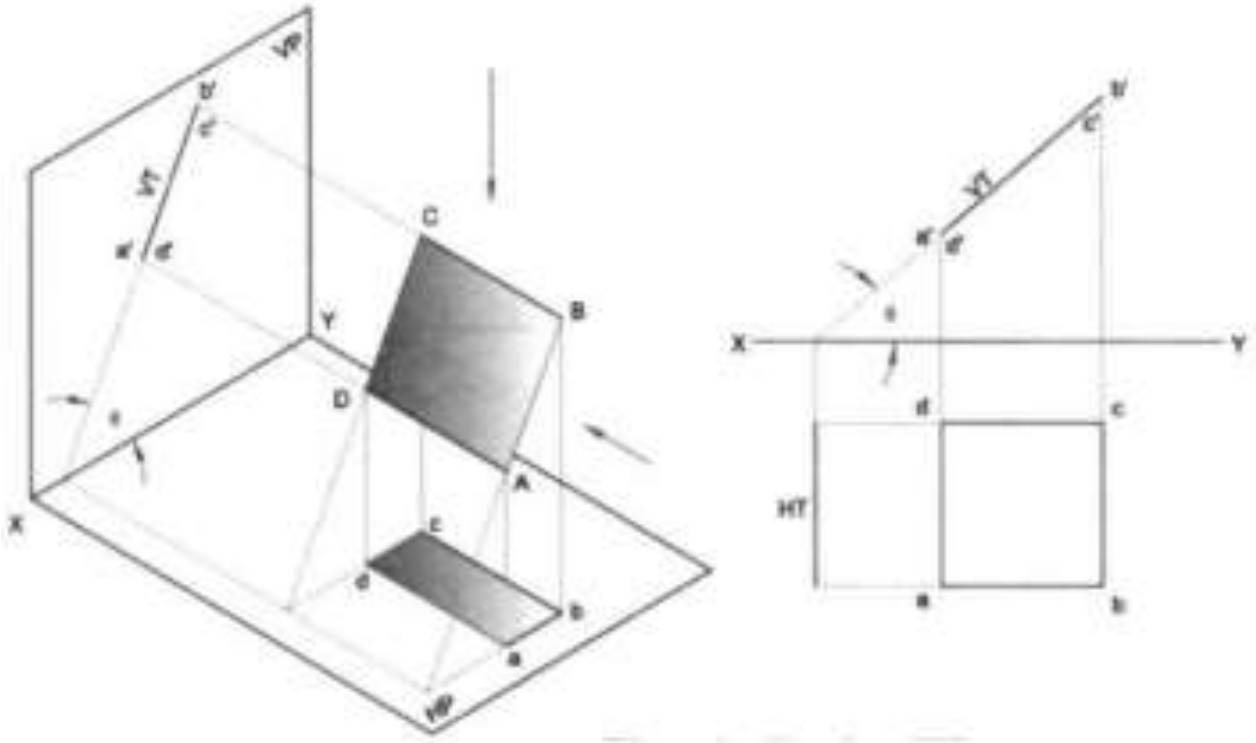
Surface of Plane Parallel to the HP (and perpendicular to VP)



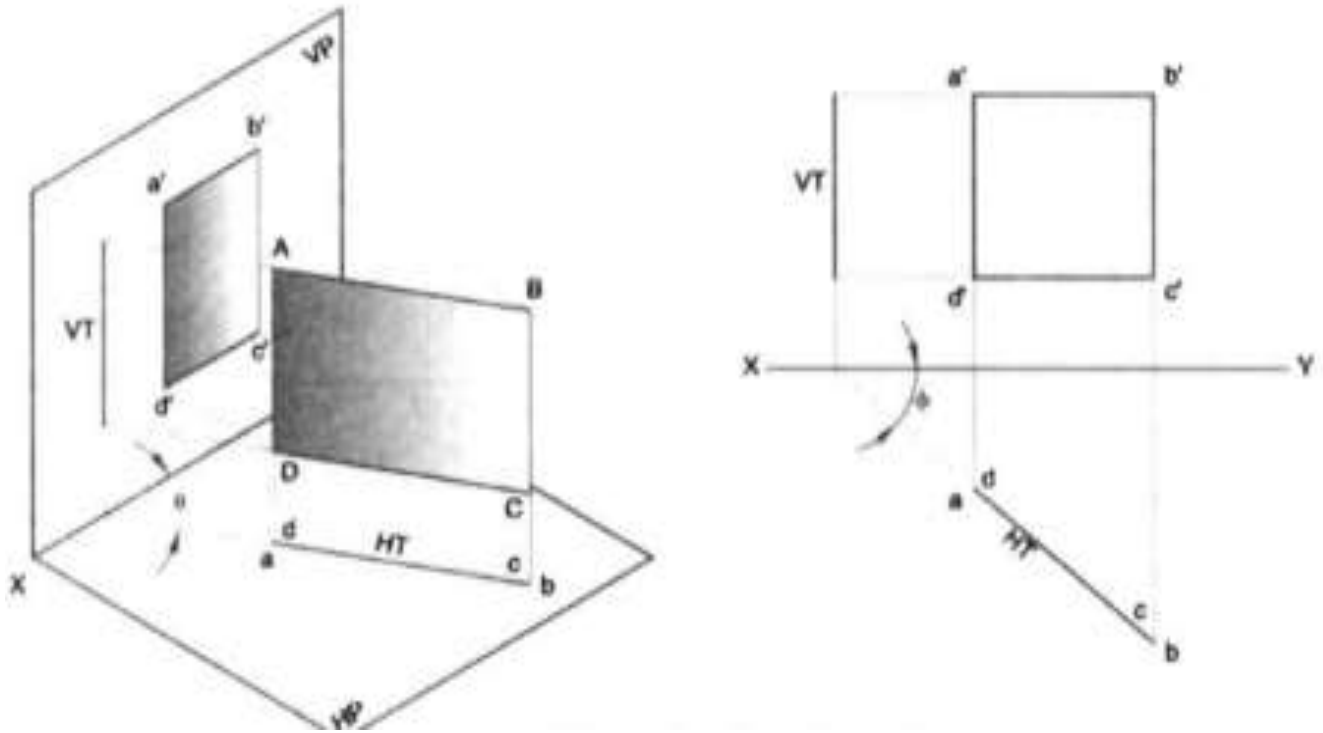
Surface of Plane Parallel to the VP (and perpendicular to HP)



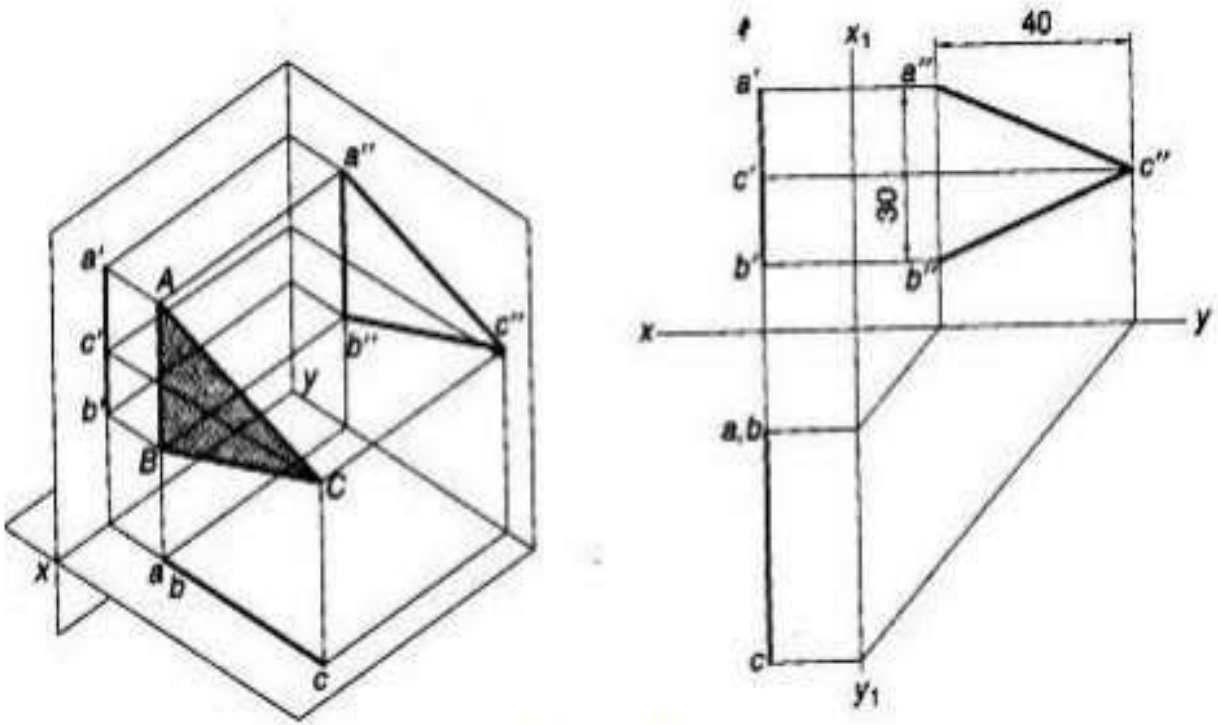
Surface of Plane Inclined to the HP and perpendicular to VP



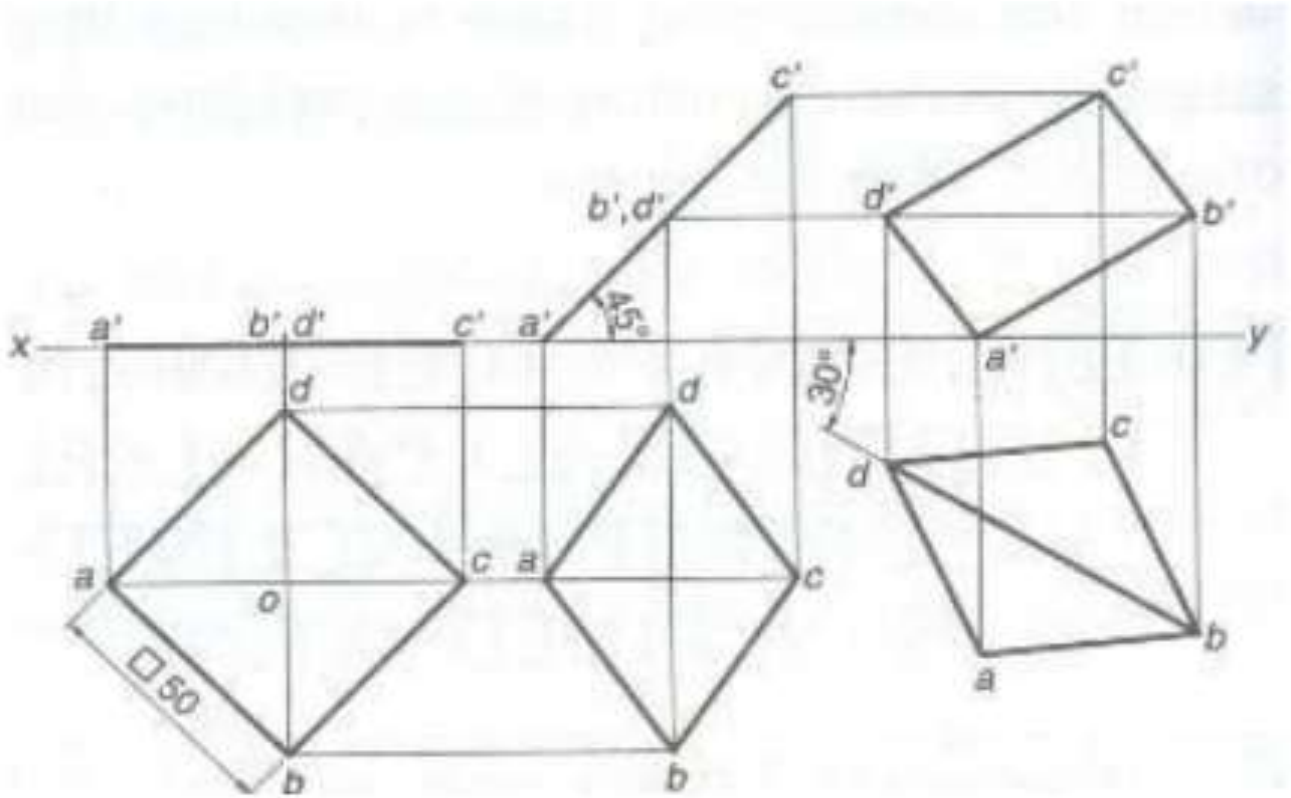
Surface of Plane Inclined to the VP and perpendicular to HP



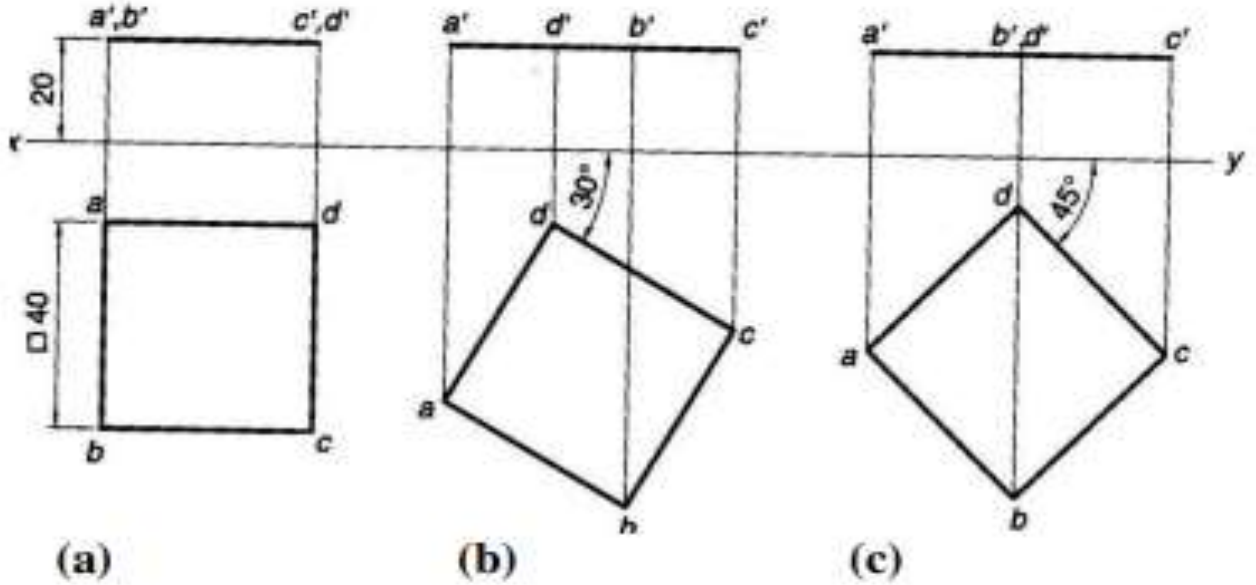
Surface of Plane Perpendicular to Both HP and VP



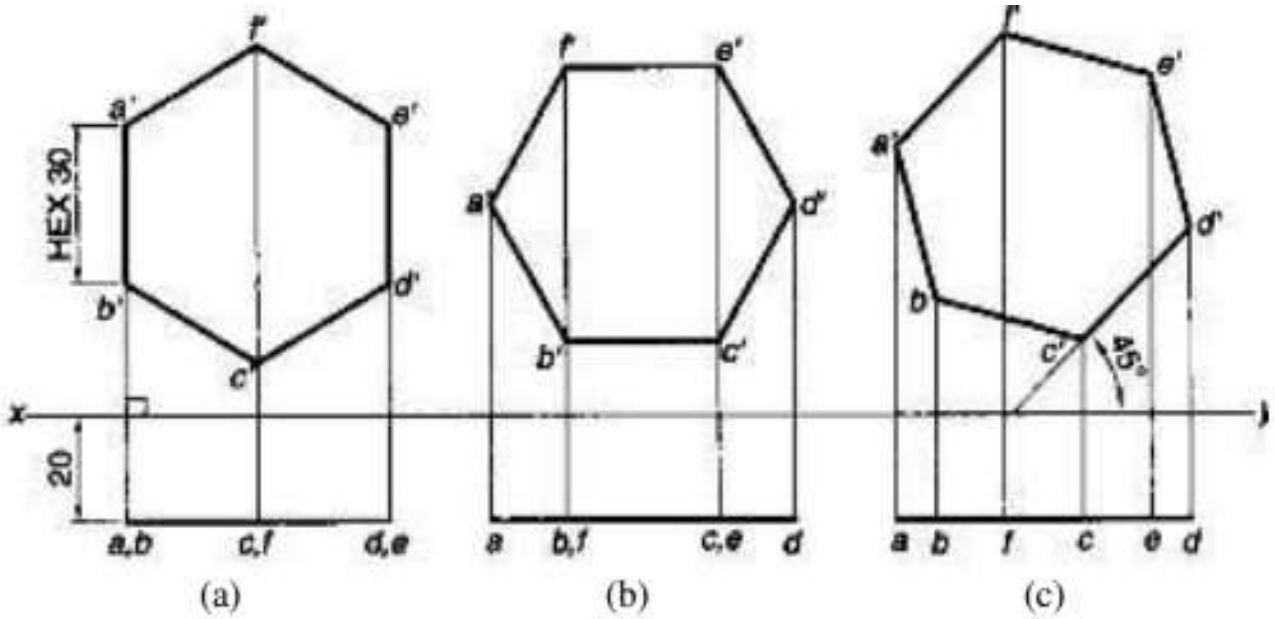
Surface of Plane is Inclined to Both HP and VP



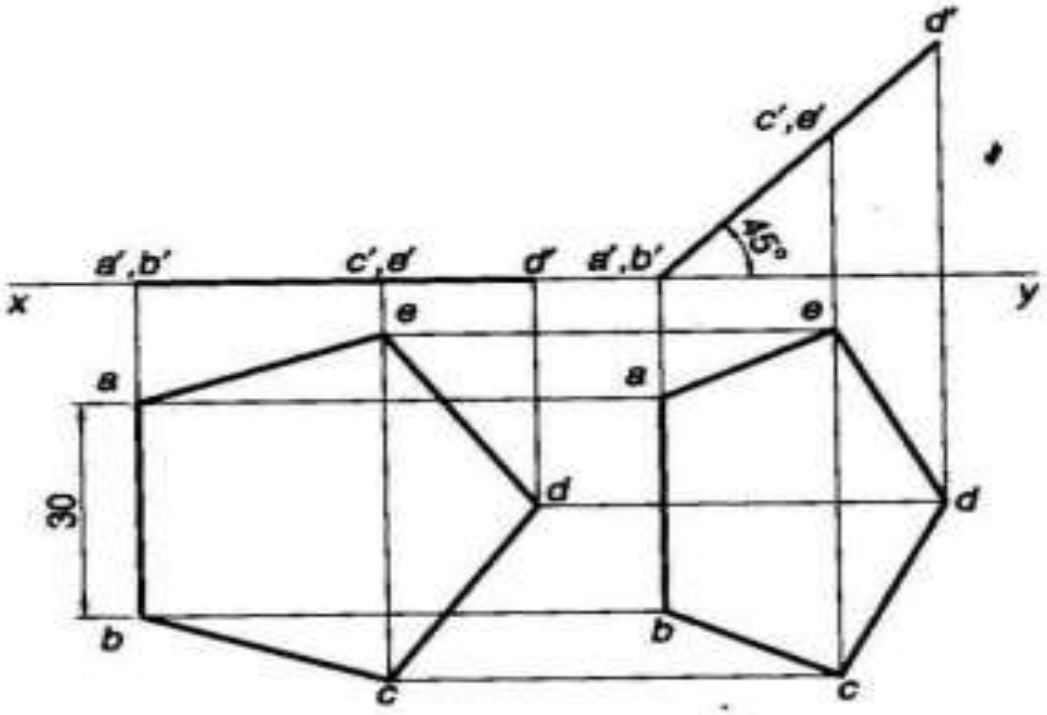
A Square plane with a 40mm side has its surface parallel to and 20mm above the HP. Draw its Projections, when (a) A side is parallel to VP (b) A side is inclined at 300 to VP and (c) All sides are equally inclined to VP.



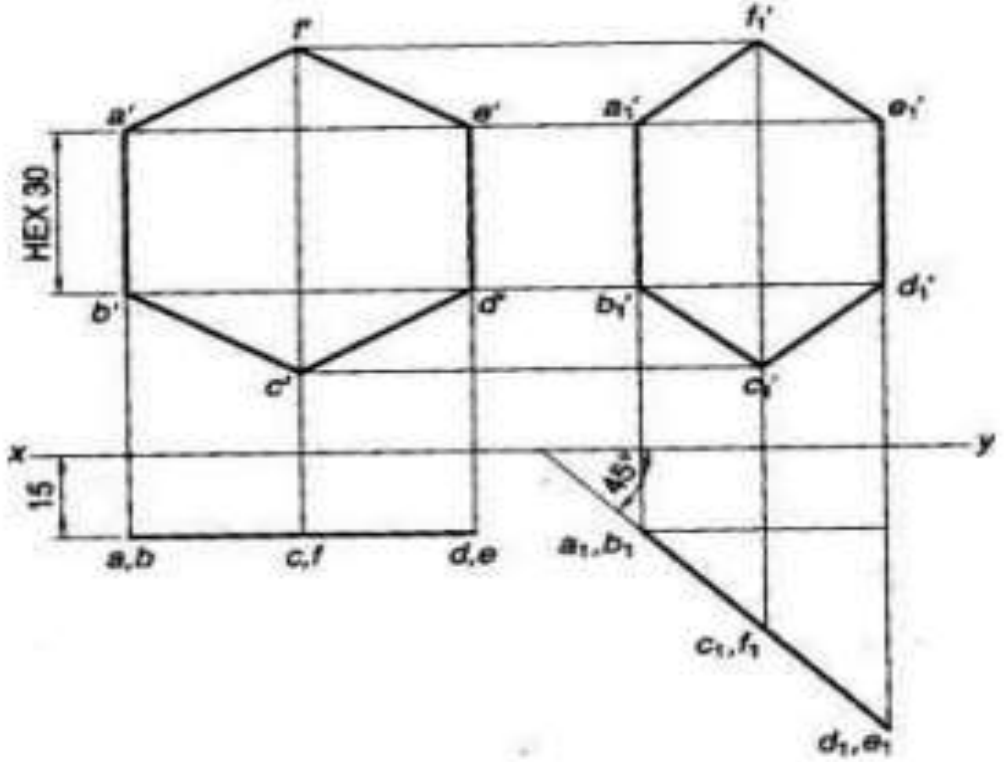
A Hexagonal plane with a 30mm side has its surface parallel to and 20mm in front of the VP. Draw it's Projections, when (a) a side is perpendicular to HP (b) a side is parallel to the HP (c) Side is inclined at 450 to the HP



A Pentagonal plane with a 30mm side has an edge on the HP, the surface of the Plane is inclined at 450 to the HP. Draw it's Projections



A Hexagonal plate with a 30mm side and negligible thickness has its surface perpendicular to the HP and inclined at 450 to the VP. Draw it's Projections? When one of it's sides of the Plane is Parallel to and 15 mm in front of the VP



A Circular plane with a 60mm Diameter is resting on a point it's circumference on the VP. The center is 40 mm above the HP , and The surface is inclined at 450 to the VP. And perpendicular to the HP Draw It's Projections

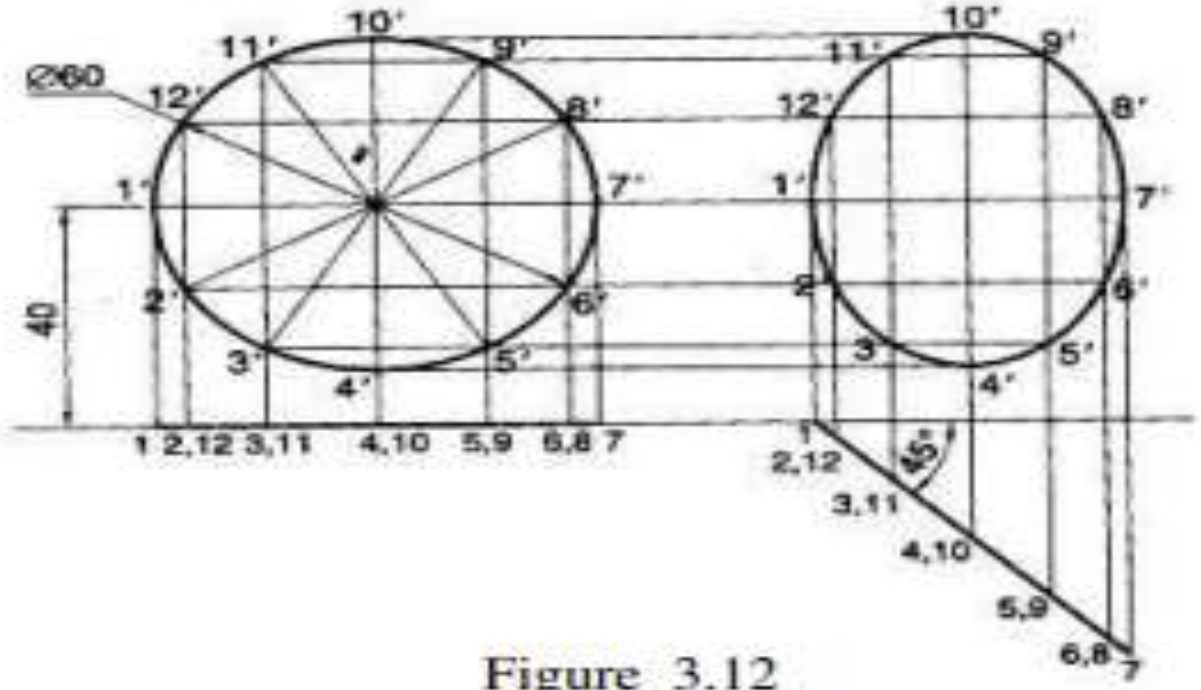


Figure 3.12

PROJECTION OF SOLIDS

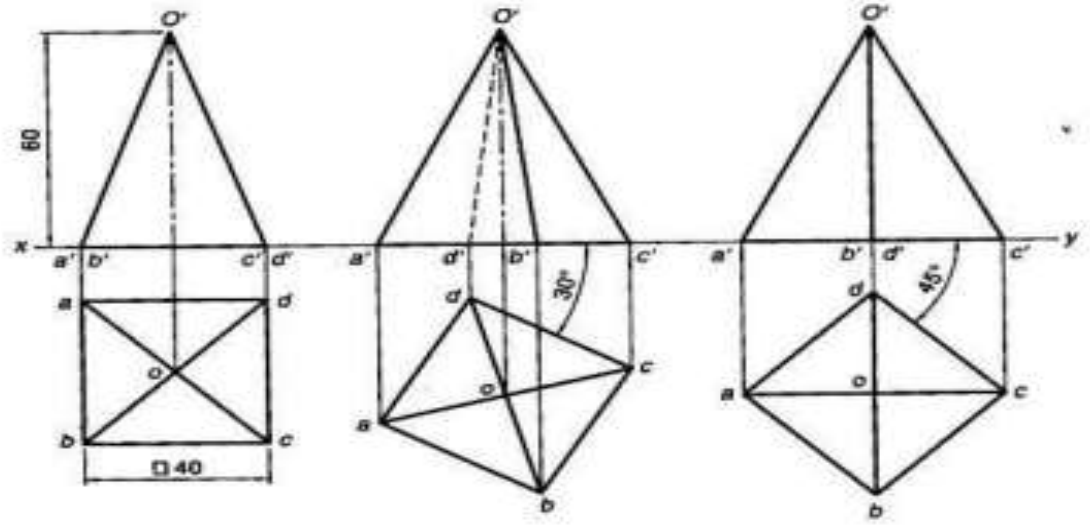
- A solid has three dimensions, the length, breadth and thickness or height. A solid may be represented by orthographic views, the number of which depends on the type of solid and its orientation with respect to the planes of projection.
- solids are classified into two major groups.
- (i) Polyhedral, and (ii) Solids of revolution
- **POLYHEDRAL**
- A polyhedral is defined as a solid bounded by plane surfaces called faces. They are:
- (i)Regular polyhedral (ii) Prisms and (iii) 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 centers of the bases is called the axis of the prism.

PROJECTION OF SOLIDS

- **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.
- **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

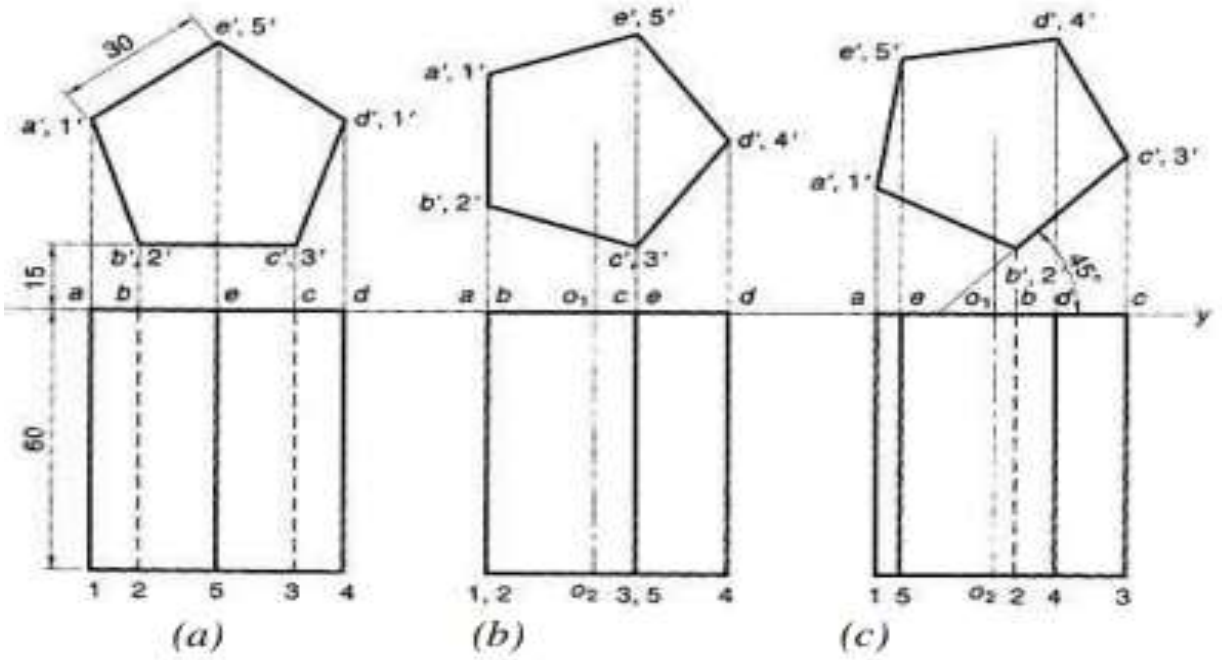
Axis perpendicular to HP

- A Square Pyramid, having base with a 40 mm side and 60mm axis is resting on its base on the HP. Draw its Projections when (a) a side of the base is parallel to the VP. (b) A side of the base is inclined at 300 to the VP and (c) All the sides of base are equally inclined to the VP.



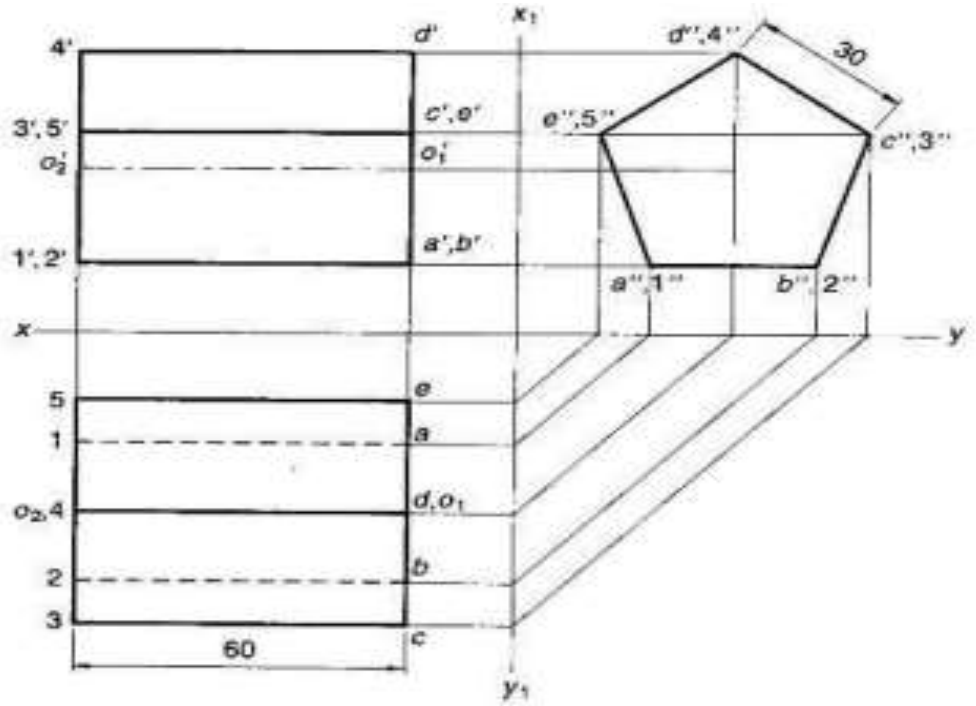
Axis perpendicular to VP

- A pentagonal Prism having a base with 30 mm side and 60mm long Axis, has one of It's bases in the VP. Draw Its projections When (a)rectangular face is parallel to and 15 mm above the HP (b) A rectangular face perpendicular to HP and (c) a rectangular face is inclined at 450 to the HP



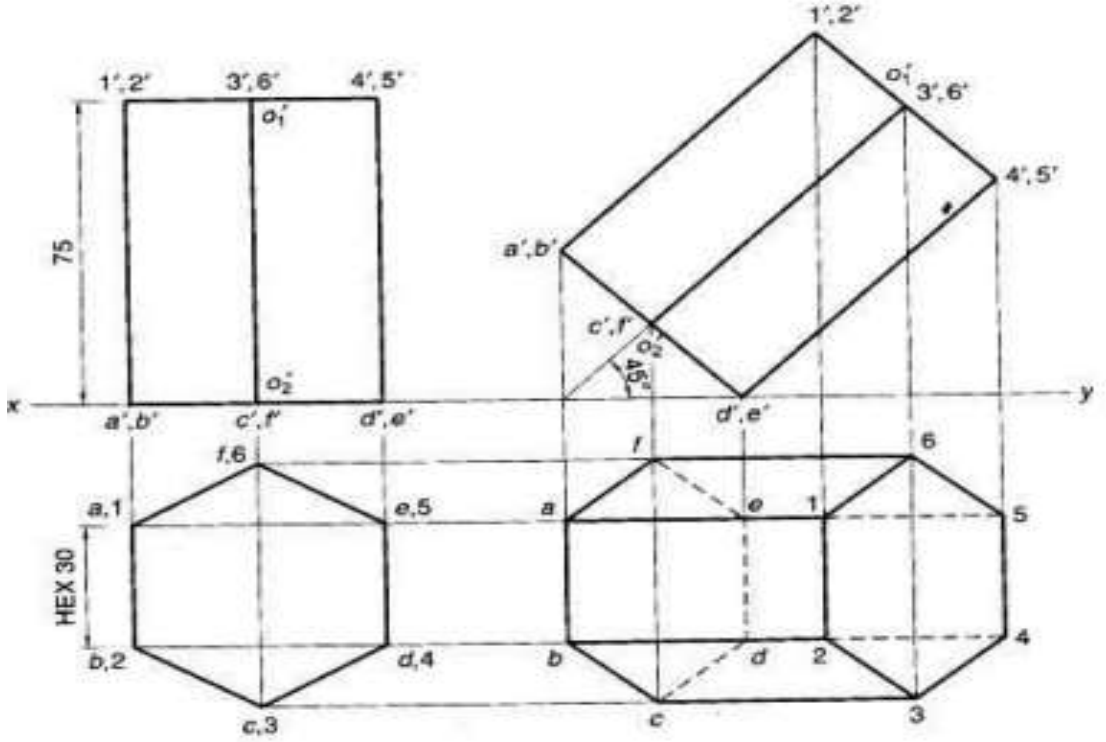
Axis parallel to both the HP and VP

- A pentagonal Prism having a base with a 30 mm side and 60mm long axis, is resting on one of its rectangular faces on the HP. with axis parallel to the VP. Draw its projections



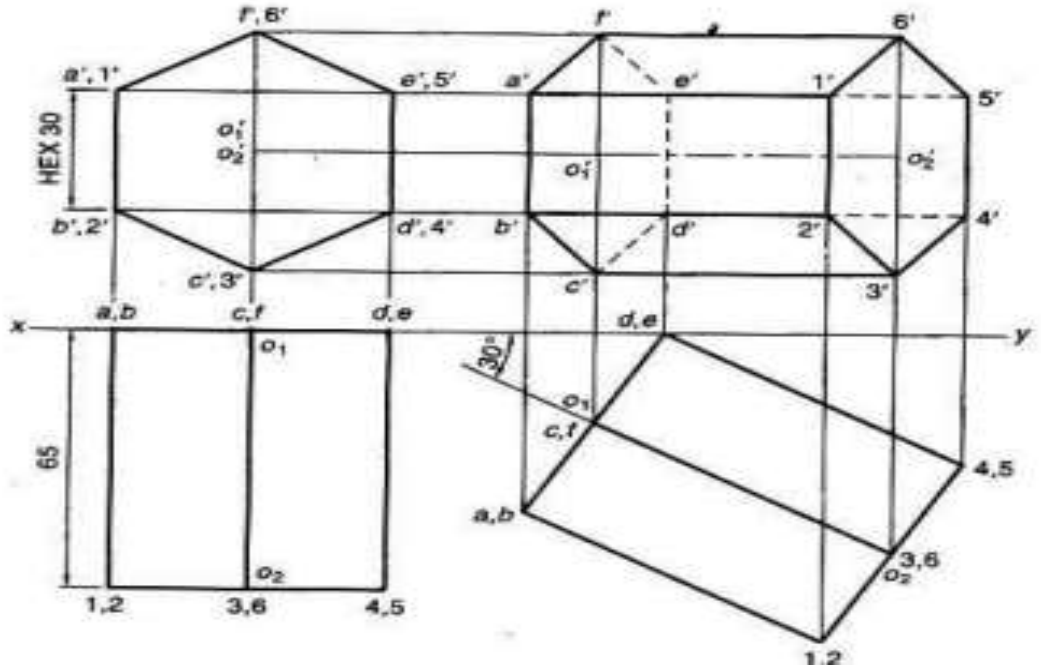
Axis inclined to HP and parallel to VP

- A Hexagonal Prism having a base with a30 mm side and 75 mm long axis, has an edge its base on the HP. Its axis is Parallel to the VP and inclined at 450 to the HP Draw its projections

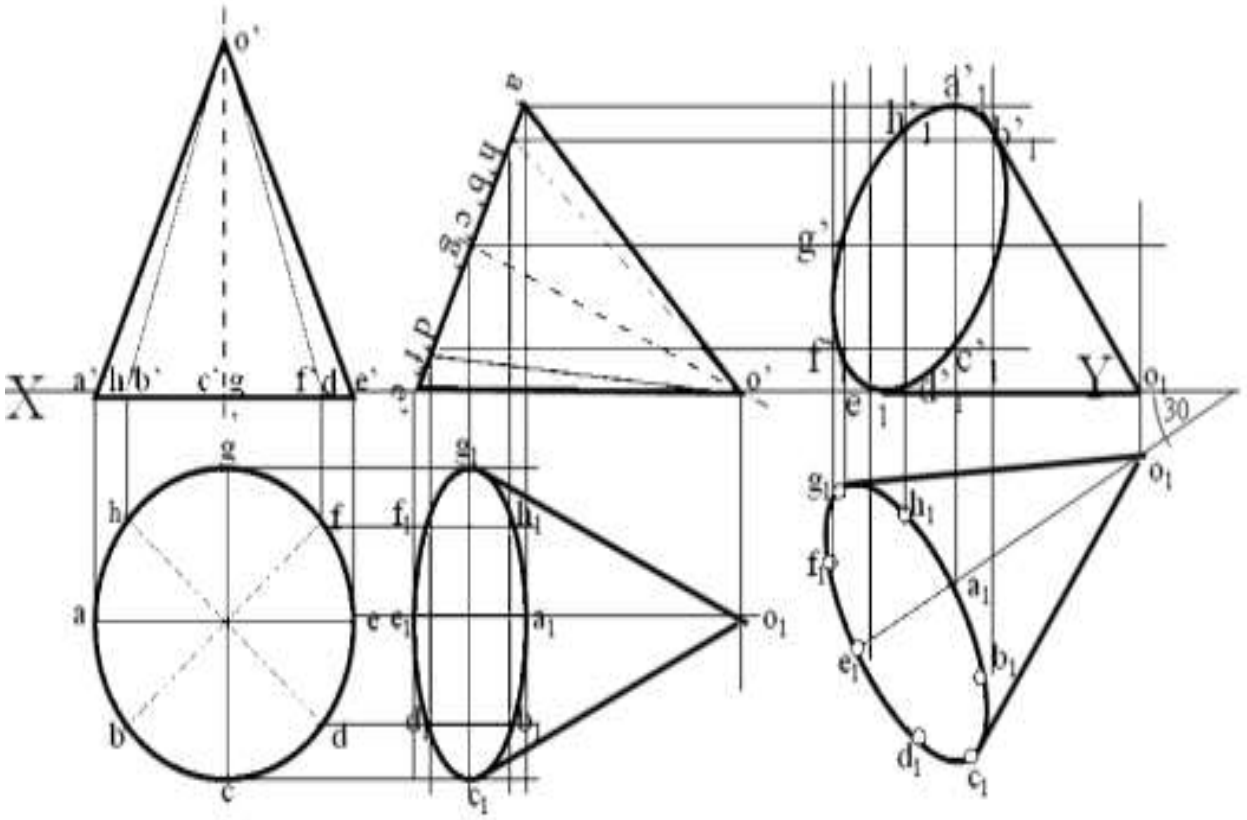


Axis inclined to VP and parallel to HP

- An Hexagonal Prism, having a base with a 30 mm side and 65 mm long axis, has an edge it's base in the VP Such that the axis is inclined at 300 to the VP and Parallel to the HP. Draw its Projections



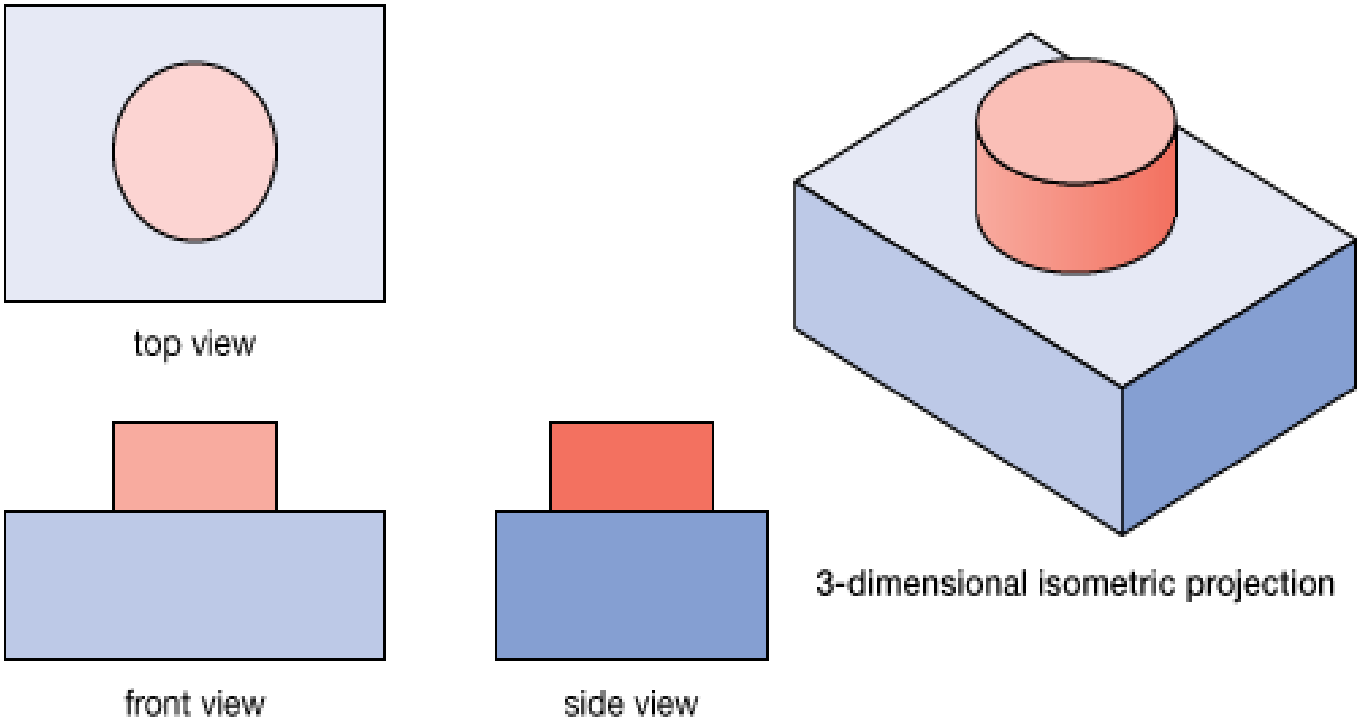
A cone 40 mm diameter and 50 mm axis is resting on one of its generator on HP which makes 300 inclinations with VP. Draw it's projections



Orthographic projection

- **orthographic projection**, common method of representing three-dimensional objects, usually by three two-dimensional drawings in each of which the object is viewed along parallel lines that are perpendicular to the plane of the drawing. For example, an orthographic projection of a house typically consists of a top view, or plan, and a front view and one side view (front and side elevations).

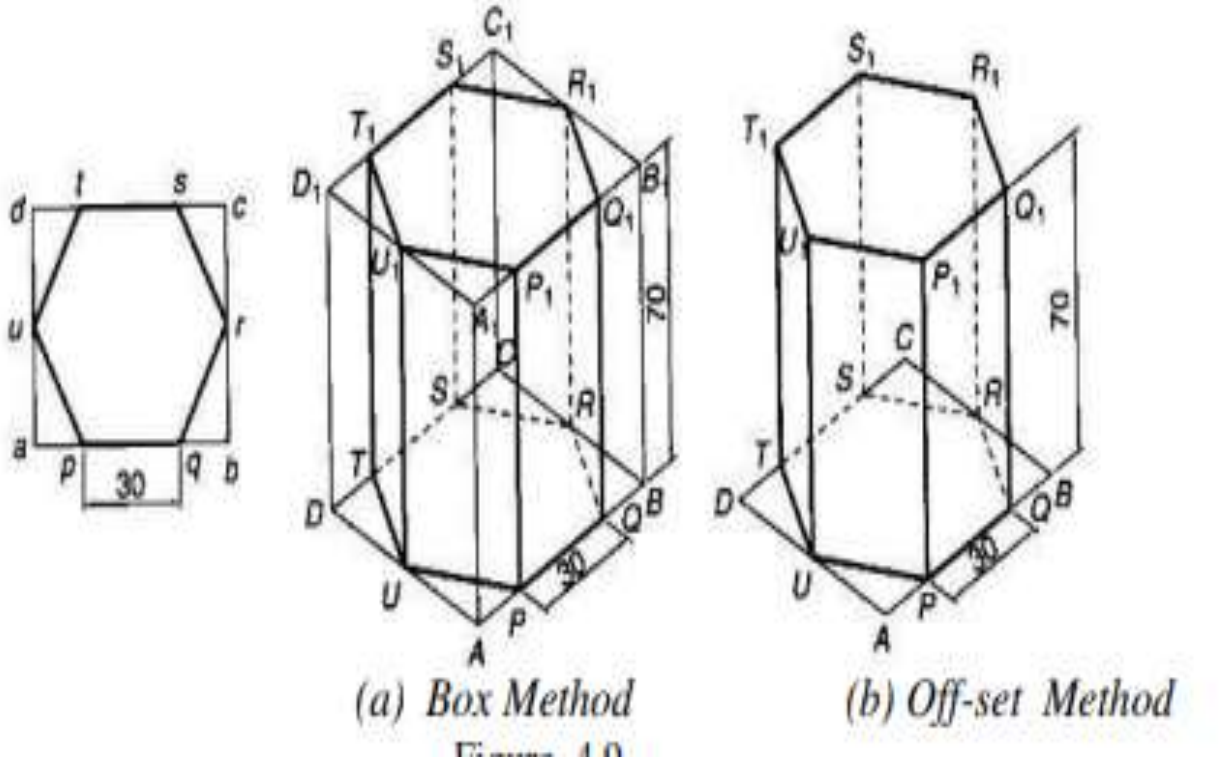
Orthographic and isometric projections of an object



Isometric projection

- **Isometric projection:** Isometric projection is a type of pictorial projection in which the three dimensions of a solid are not only shown in one view but their actual sizes can be measured directly from it. The three lines AL, AD and AH, meeting at point A and making 1200 angles with each other are termed Isometric Axes. The lines parallel to these axes are called Isometric Lines. The planes representing the faces of the cube as well as other planes parallel to these planes are called Isometric Planes.
- **Isometric scale:** When one holds the object in such a way that all three dimensions are visible then in the process all dimensions become proportionally inclined to observer's eye sight and hence appear apparent in lengths. This reduction is 0.815 or 9/11 (approx.). It forms a reducing scale which is used to draw isometric drawings and is called Isometric scale. In practice, while drawing isometric projection, it is necessary to convert true lengths into isometric lengths for measuring and marking the sizes.

Draw isometric view of a hexagonal prism having a base with 30 mm side and a 70mm long axis resting on its base on the HP. With an edge of the base parallel to the VP when (a) using Box Methods (b) using Off-set Method



(a) Box Method (b) Off-set Method

AutoCAD

- AutoCAD is a software application developed for PCs, that enables computer-aided design (CAD) and drafting. The software is used to produce 2D and 3D drawings. This software allows users to conceptualize ideas, and produce designs and drawings. Technical accuracy, rapid design calculations, and simulations are possible with AutoCAD for professionals across industries.

Applications of AutoCAD Software

- Many experts from numerous sectors utilize the computer-aided design (CAD) program AutoCAD. Here is a quick overview of some of the most frequent AutoCAD users:
- **Architects:** It is often used by architects to build blueprints and sketches for both personal and public spaces like homes, schools, cafes, malls, etc. The platform also comes with built-in tools that can analyze and correct weaknesses in a building's design.
- **Interior Designers:** It is used to imagine the interior of a building, whether it's a shopping area of a mall or an entrance to a hotel.
- **Fine Artists:** Artists use this software to draft sculptures, wood carvings, engravings, and experimental art pieces.
- **Engineers-** As a mechanical engineer, you can use this to create manufacturing processes as well as to design motor parts, robots, and other innovative objects. As an electrical engineer, you can use the software to map out electrical systems, while as a civil engineer, you can use AutoCAD to design roads, bridges, highways, etc.

Benefits of AutoCAD

- It offers its users multiple advantages. Some of the main advantages of AutoCAD are as follows:
- **Simplicity-** It helps you work on simple designs such as graphs or presentations, etc. and helps you enhance them.
- **Complex Production –** Complex designs like the architecture of a building can be created easily using AutoCAD.
- **Useful Features –** It helps designers create their designs quickly and offers various useful features.
- **Easy edits-** With this, you can change and manipulate designs seamlessly, instead of manually revising them, creating an entirely new draft, or editing the draft you had.
- **Faster Production**– You can generate a reusable block library to reproduce design parts. This software even allows you to save it to your block library which can be used and reused later.
- **Accuracy-** It allows you to design down to fractions to ensure better accuracy. This helps to create accurate designs in all dimensions.
- **Easy access-** The files in AutoCAD can also be easily saved and stored in the cloud, so they can be accessed anywhere at any time.

CommandsofAutoCad

Command	Keystroke	Icon	Menu	Result
Line	Line / L		Draw > Line	Draw a straight line segment from one point to the next
Circle	Circle / C		Draw > Circle > Center, Radius	Draws a circle based on a center point and radius.
Erase	Erase / E		Modify > Erase	Erases an object.
Print	Print / Plot Cntl+P		File > Print	Enables the Print/Plot Configuration Dialog Box
Undo	U (Don't use 'Undo' for now)		Edit > Undo	Undoes the last command.
Rectangle	RECTANGLE / REC		Draw > Rectangle	Draws a rectangle after you enter one corner and then the second.
Multi Lines	MLINE / ML	No Icon	Draw > Multiline	Draw parallel lines based on the parameters you define.
Trim	TRIM / TR		Modify > Trim	Trims objects to a selected cutting edge.
Extend	EXTEND / EX		Modify > Extend	Extends objects to a selected boundary edge.
Offset	OFFSET / O		Modify > Offset	Offsets an object (parallel) by a set distance.
Object Snaps	OSNAP / OS / F3	CLICK	Tools > Object Snap Settings	Brings up the OSNAP dialog box.

CommandsofAutoCad

Command	Keystroke	Icon	Menu	Result
Move	Move / M		Modify > Move	Moves an object or objects
Copy	Copy / CP		Modify > Copy	Copies object(s) once or multiple times
Stretch	Stretch / S		Modify > Stretch	Stretches an object after you have selected a portion of it
Mirror	Mirror / MI		Modify > Mirror	Creates a mirror image of an object or selection set
Rotate	Rotate / RO		Modify > Rotate	Rotates objects to a certain angle
Fillet	Fillet / F		Modify > Fillet	Creates a round corner between two lines
Chamfer	Chamfer / CHA		Modify > Chamfer	Creates an angled corner between two lines
Array	Array / AR		Modify > Array	Creates a repeating pattern of the selected objects
Layer	Layer / LA		Format > Layer	Starts the Layer and Linetype property dialog box
Text	Text	No Icon	Draw > Single Line Text	Creates a single line of text
Dimension	Dim	Many	Dimension > (pick one)	Dimensions previously drawn objects
Scale	Scale / SC		Modify > Scale	Proportionately resizes (or scales) objects

CommandsofAutoCad

ICON	SETTING		ICON	SETTING
	Endpoint			Perpendicular
	Midpoint			Tangent
	Center			Nearest
	Node			Apparent Intersection
	Quadrant			Parallel
	Intersection			None
	Extension			Osnap Setting
	Insertion Point			Temporary Tracking Point
				Snap From