1.1 Introduction

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 visualise objects.

Drawings prepared in one country may be utilised in any other country irrespective of the language spoken. Hence, engineering drawing is called the universal language of engineers. Any language to be communicative, should follow certain rules so that it conveys the same meaning to every one. Similarly, drawing practice must follow certain rules, if it is to serve as a means of communication. For this purpose, Bureau of Indian Standards (BIS) adapted the International Standards on code of practice for drawing. The other foreign standards are : DIN of Germany, BS of Britain and ANSI of America.

1.2 Role of Engineering Drawing

The ability to read drawing is the most important requirement of all technical people in any profession. As compared to verbal or written description, this method is brief and more clear. Some of the applications are : building drawing for civil engineers, machine drawing for mechanical engineers, circuit diagrams for electrical and electronics engineers, computer graphics for one and all.

The subject in general is designed to impart the following skills.

1. Ability to read and prepare engineering drawings.
2. Ability to make free – hand sketching of objects.
3. Power to imagine, analyse and communicate, and
4. Capacity to understand other subjects.

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1.3 Drawing Instrument and Aids

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

1. Drawing board
2. Mini draughter
3. Instrument box
4. Set squares
5. Protractor
6. Set of scales
7. French curves
8. Drawing sheets
9. Pencils
10. Templates

1.3.1 Drawing Board

Until recently drawing boards used are made of well seasoned softwood of about 25 mm thick with a working edge for T-square. Now a days mini-draughters are used instead of T-squares which can be fixed on any board. The standard size of board depends on the size of drawing sheet size required.

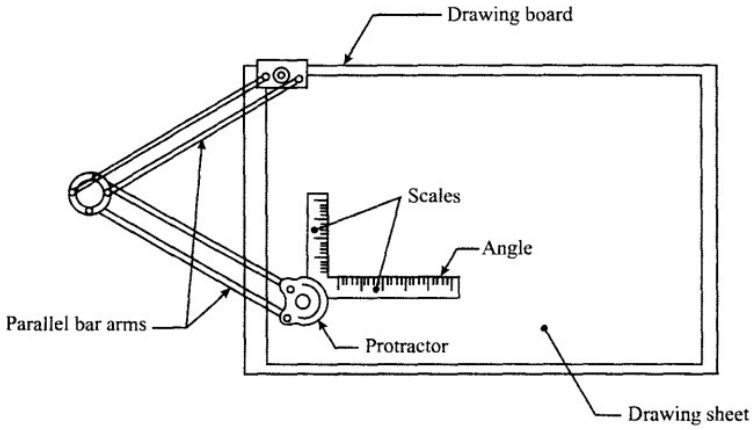


Fig. 1.1 Mini-draughter

1.3.2 Mini-Draughter

Mini-draughter consists of an angle formed by two arms with scales marked and rigidly hinged to each other (Fig.1.1). 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.

1.3.7 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 (Fig.1.6).

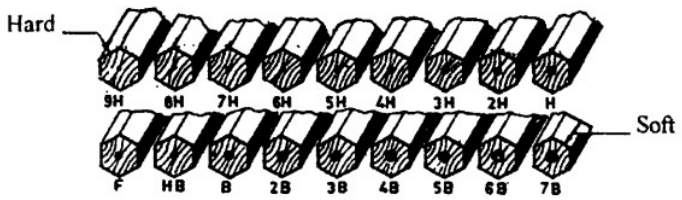


Fig. 1.6 Pencil Leads

The selection of the grade depends on the line quality desired for the drawing. Pencils of grades H or 2H may be used for finishing a pencil drawing as these give a sharp black line. Softer grade pencils are used for sketching work. HB grade is recommended for lettering and dimensioning.

Dimension Termination and Origin Indication

Dimension lines should show distinct termination in the form of arrow heads or oblique strokes or where applicable an origin indication (Fig.2.22). The arrow head included angle is 15°. The origin indication is drawn as a small open circle of approximately 3 mm in diameter. The proportion lenght to depth 3 : 1 of arrow head is shown in Fig.2.23.

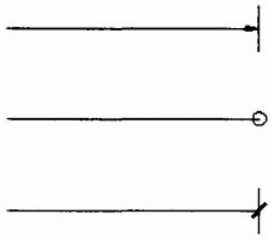
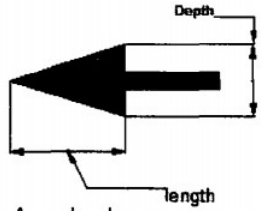


Fig. 2.22 Termination of Dimension Line



3.1 Introduction

It is not possible always 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.

3.2 Reducing and Enlarging Scales

Objects which are very big in size can not be represented in drawing to full size. In such cases the object is represented in reduced size by making use of reducing scales. Reducing scales are used to represent objects such as large machine parts, buildings, town plans etc. A reducing scale, say 1:10 means that 10 units length on the object is represented by 1 unit length on the drawing.

Similarly, for drawing small objects such as watch parts, instrument components etc., use of full scale may not be useful to represent the object clearly. In those cases enlarging scales are used. An enlarging scale, say 10:1 means one unit length on the object is represented by 10 units on the drawing.

The designation of a scale consists of the word. SCALE, followed by the indication of its ratio as follows. (Standard scales are shown in Fig. 3.1)

Scale 1:1 for full size scale

Scale 1: x for reducing scales (x = 10,20.....etc.,)

Scale x:1 for enlarging scales.

Note : *For all drawings the scale has to be mentioned without fail.*

3.3 Representative Fraction

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

$$RF = \frac{\text{Drawing size of an object}}{\text{Its actual size}} \text{ (in same units)}$$

For example, if an actual length of 3 metres of an object is represented by a line of 15mm length on the drawing

$$RF = \frac{15mm}{3m} = \frac{15mm}{(3\times1000)mm} = \frac{1}{200} \text{ or } 1:200$$

If the desired scale is not available in the set of scales it may be constructed and then used.

Metric Measurements

10 millimetres (mm) = 1 centimetre(cm)

10 centimetres (cm) = 1 decimetre(dm)

10 decimetre (dm) = 1 metre(m)

10 metres (m) = 1 decametre (dam)

10 decametre (dam) = 1 hectometre (hm)

10 hectometres (hm) = 1 kilometre (km)

1 hectare = 10,000 m^2

3.4 Types of Scales

The types of scales normally used are:

1. Plain scales.
2. Diagonal Scales.
3. Vernier Scales.

3.4.1 Plain Scales

A plain scale is simply a line which is divided into a suitable number of equal parts, the first of which is further sub-divided into small parts. It is used to represent either two units or a unit and its fraction such as km and hm, m and dm, cm and mm etc.

Problem 1 : *On a survey map the distance between two places 1km apart is 5 cm. Construct the scale to read 4.6 km.*

Solution : (Fig 3.2)

$$RF = \frac{5cm}{1\times1000\times100cm} = \frac{1}{20000}$$

5.1 Introduction

In the preceding chapters 1 to 4 **plane geometry,** where the constructions of the geometrical figures having only two dimensions are discussed, **solid geometry** is delt with in the following chapters.

Engineering drawing, particularly solid geometry is the graphic language used in the industry to record the ideas and informations necessary in the form of blue prints to make machines, buildings, strutures etc., by engineers and technicians who design, develop, manufacture and market the products.

5.1.1 Projection

As per the optical physics, an object is seen when the light rays called visual rays coming from the object strike the observer's eye. The size of the image formed in the retina depends on the distance of the observer from the object.

If an imaginary transparent plane is introduced such that the object is in between the observer and the plane, the image obtained on the screen is as shown in Fig.5.1. This is called **perspective view** of the object. Here, straight lines (rays) are drawn from various points on the contour of the object to meet the transparent plane, thus the object is said to be **projected** on that plane.

WORKSHEET-1

LETTERING

Lettering is defined as writing of titles, sub-titles, dimensions, etc., on a drawing.

Importance of Lettering:

To undertake production work of an engineering component as per the drawing, the size and other details are indicated on the drawing. This is done in the form of notes and dimensions. Main Features of Lettering are legibility, uniformity and rapidity of execution. Use of drawing instruments for lettering consumes more time. Lettering should be done freehand with speed. Practice accompanied by continuous efforts would improve the lettering skill and style. Poor lettering mars the appearance of an otherwise good drawing.

Size of Letters:

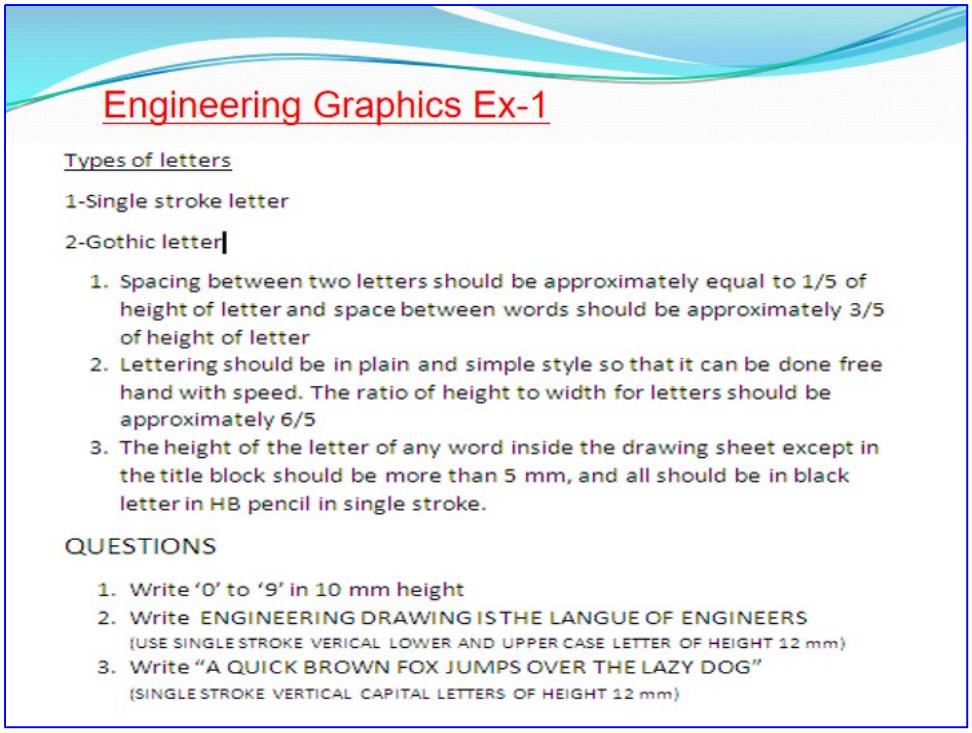
- Size of Letters is measured by the height h of the CAPITAL letters as well as numerals.
- Standard heights for CAPITAL letters and numerals recommended by BIS are given below: 1.8, 2.5, 3.5, 5, 6, 10, 14 and 20 mm

Note: Size of the letters may be selected based upon the size of drawing.

Guide Lines:

In order to obtain correct and uniform height of letters and numerals, guide lines are drawn, using 2H pencil with light pressure. HB grade conical end pencil is used for lettering.
The following are some of the guide lines for lettering

- Drawing numbers, title block and letters denoting cutting planes, sections are written in 10 mm size.
- Drawing title is written in 7 mm size.
- Hatching, sub-titles, materials, dimensions, notes, etc., are written in 3.5 mm size.
- Space between lines = 3/4 h
- Space between words may be equal to the width of alphabet M or 3/5 h.



WORKSHEET-2

Projection of Points

Points in Space

A point may lie in space in anyone of the four quadrants. The positions of a point are:

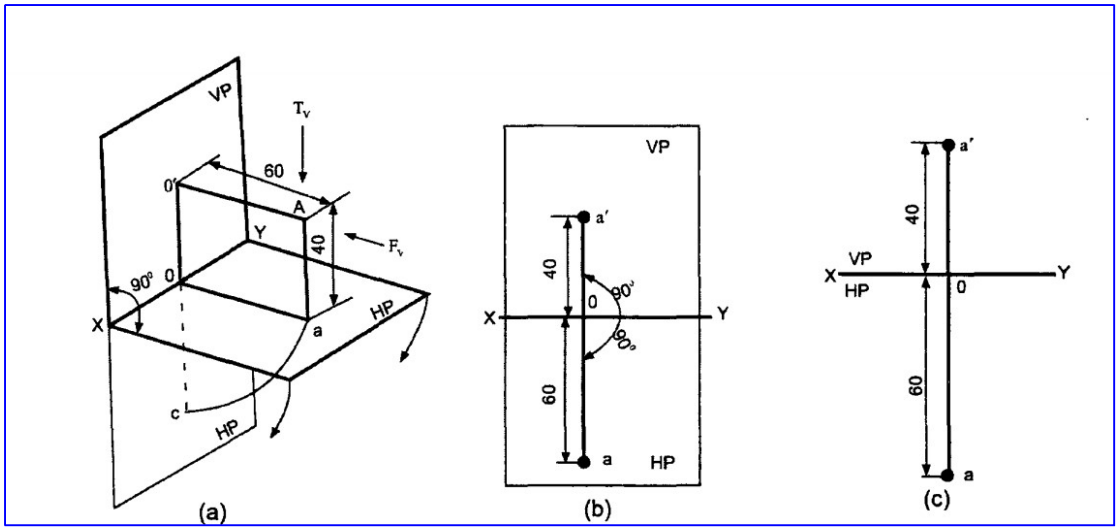
1. First quadrant, when it lies above H.P and in front of V.P.
2. Second quadrant, when it lies above HP and behind v.P.
3. Third quadrant, when it lies below H.P and behind v.P.
4. Fourth quadrant, when it lies below H.P and in front of V.P.

Knowing the distances of a point from H.P and V.P, projections on H.P and Y.P are found by extending the projections perpendicular to both the planes. Projection on H.P is called Top view and projection on Y.P is called Front view

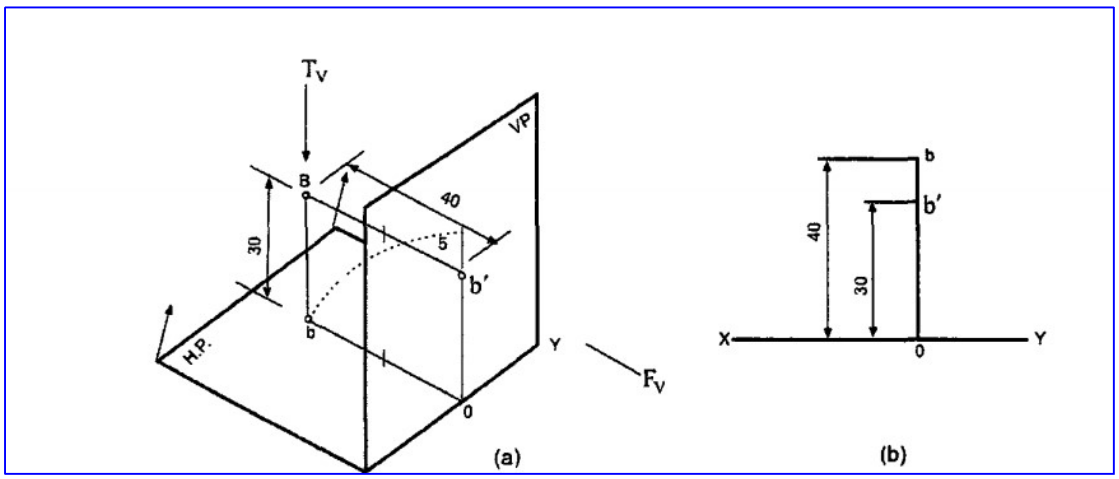
Notation followed

1. Actual points in space are denoted by capital letters A, B, C.
2. Their front views are denoted by their corresponding lower case letters with dashes a', b' , d'.etc., and their top views by the lower case letters a, b, c etc.
3. Projectors are always drawn as continuous thin lines.

Problem: *Point A is 40 mm above HP and 60 mm in front of v.P. Draw its front and top view.*

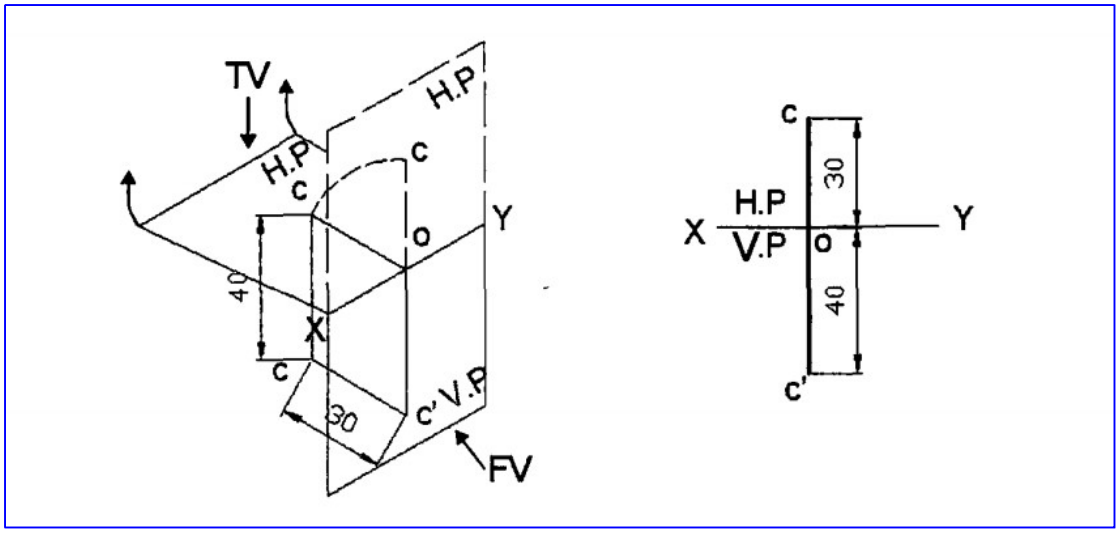


Problem : *A Point B is 30 mm above HP and 40 mm behind v.p Draw its projection.*



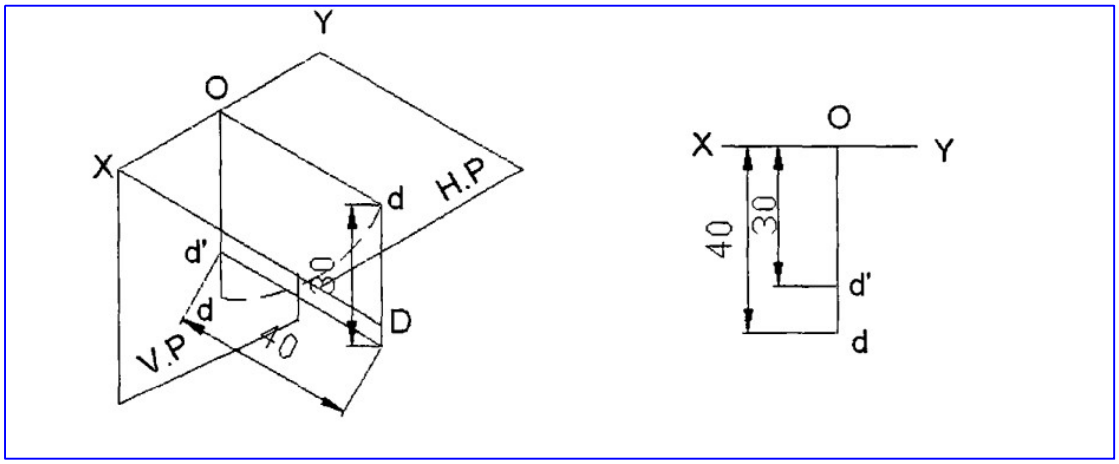
Problem : *A point* C *is 40 mm below HP and 30 mm behind v.P. Draw its projections.*

Solution : The point C is in the Ill Quadrant
1. C is 40 mn below H.P Hence c' is 40 nun below xy.
2. Draw xy and draw projector at any point on it. Mark c' 40 mm below xy on the projector.
3. C is 30 nun behind v.P. So c is 30 mm behind xy. Hence in the orthographic projections mark c 30 mm above xy on the above projector.



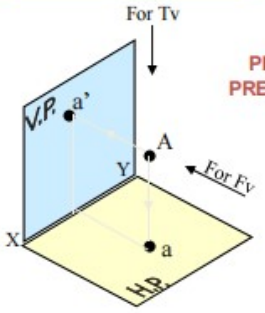
Problem: *A point D is 30 mm below HP and 40 mm in front of v.P. Draw its projection.*

Solution:The point D is in the IV Quadrant.
1. D is 30 mm below H.P. Hence, d' , is 30 mm below xy. Draw xy line and draw a projector perpendicular to it. Mark d' 30 mm below xy on the projector.
2. D is 40 mm in front of V.P; so d is 40 mm in front of xy. Therefore, mark d 40 mm below xy



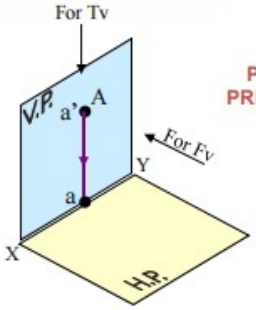
PROJECTIONS OF A POINT IN FIRST QUADRANT.

POINT A ABOVE HP & INFRONT OF VP



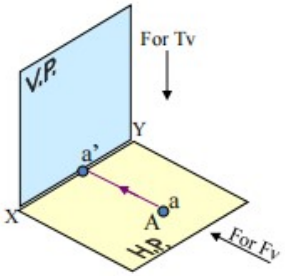
PICTORIAL PRESENTATION

POINT A ABOVE HP & IN VP



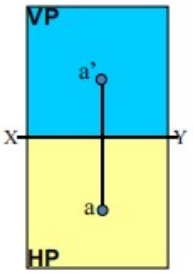
PICTORIAL PRESENTATION

POINT A IN HP & INFRONT OF VP

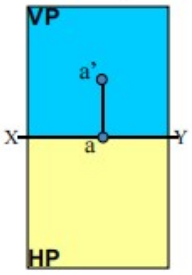


ORTHOGRAPHIC PRESENTATIONS OF ALL ABOVE CASES.

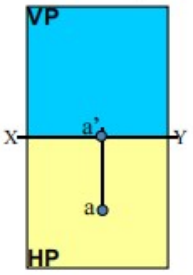
Fv above xy, Tv below xy.



Fv above xy, Tv on xy.



Fv on xy, Tv below xy.



PROJECTION OF POINTS

Q 1. Draw the projection of the points as follows and state its position With respect to reference planes

a) Top view on xy line and front view 40 mm above xy line.
b) Top view on xy, line and front view 25 mm below xy line.
c) Top view and front view both on xy line.
d) Top view 40 mm above xy line and front view 30 mm below xy line.
e) Top view 30 mm below xy line and front view 45 mm below xy line.
f) Top view 25 mm below xy line and front view 40 mm below xy line.

Q 2. Draw the projection of the following points on the same ground line keeping the projectors 50 mm apart. The point is

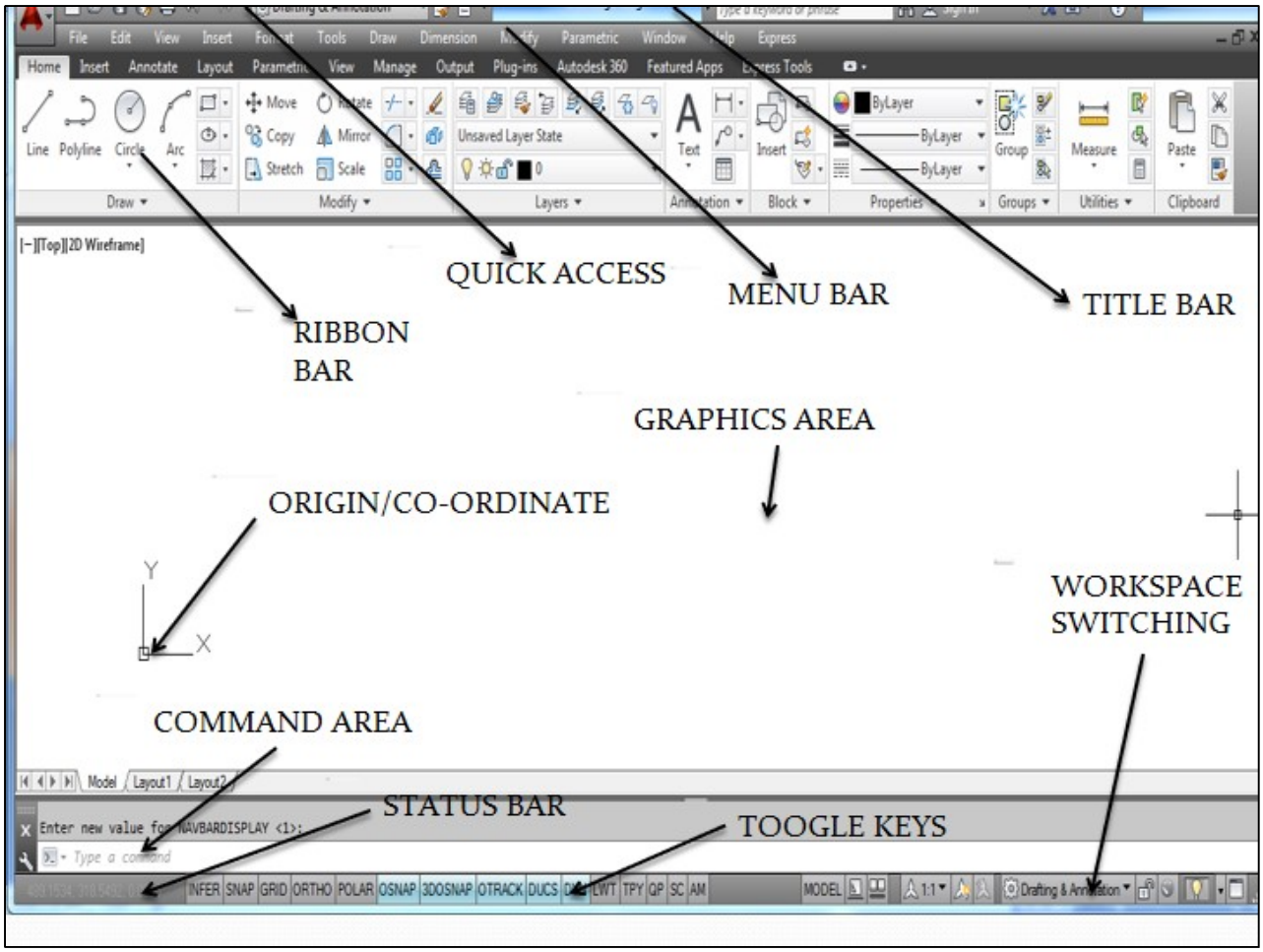
a) 40 mm below the H.P and 30 mm behind the V.P
b) 25 mm above the H.P and 35 mm behind the V.P
c) In the H.P and 30 mm behind the V.P
d) In the H.P and 40 mm front of V.P
e) 35 mm above the H.P and in the V.P
f) In the H.P and in the V.P

AUTO CAD

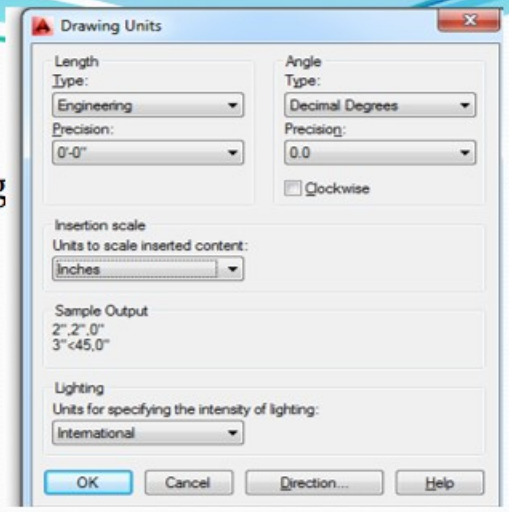
Automatic Computer Aided Design/Drafting
LAUNCHED-Invented by John Walker 1982 21st dec. and marketed by Autodesk company.
First Version : MicroCAD

R1……..R20 ,
2000……..2019

APPLICATION-mechanical ,civil, Electrical etc..
Feature- 2D Sketch ,layer setting, Isometric view,3D wirefrem,3D solid modeling, Realistic view
Advantages- 1. 3D View
2. Less Time and Man Power
3. Less Waste of Money and Material
4. Accuracy

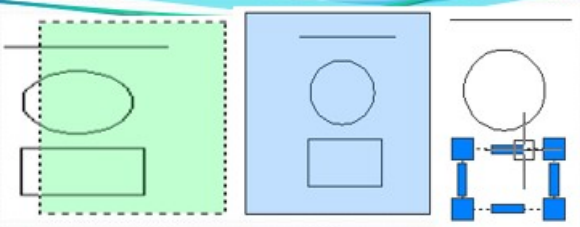


- Units
  - Un ↵
    - Type : engineering
    - Precision : 0'.0"
    - Scale : inches
    - OK

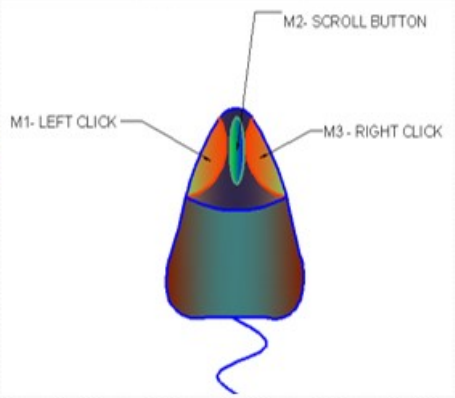


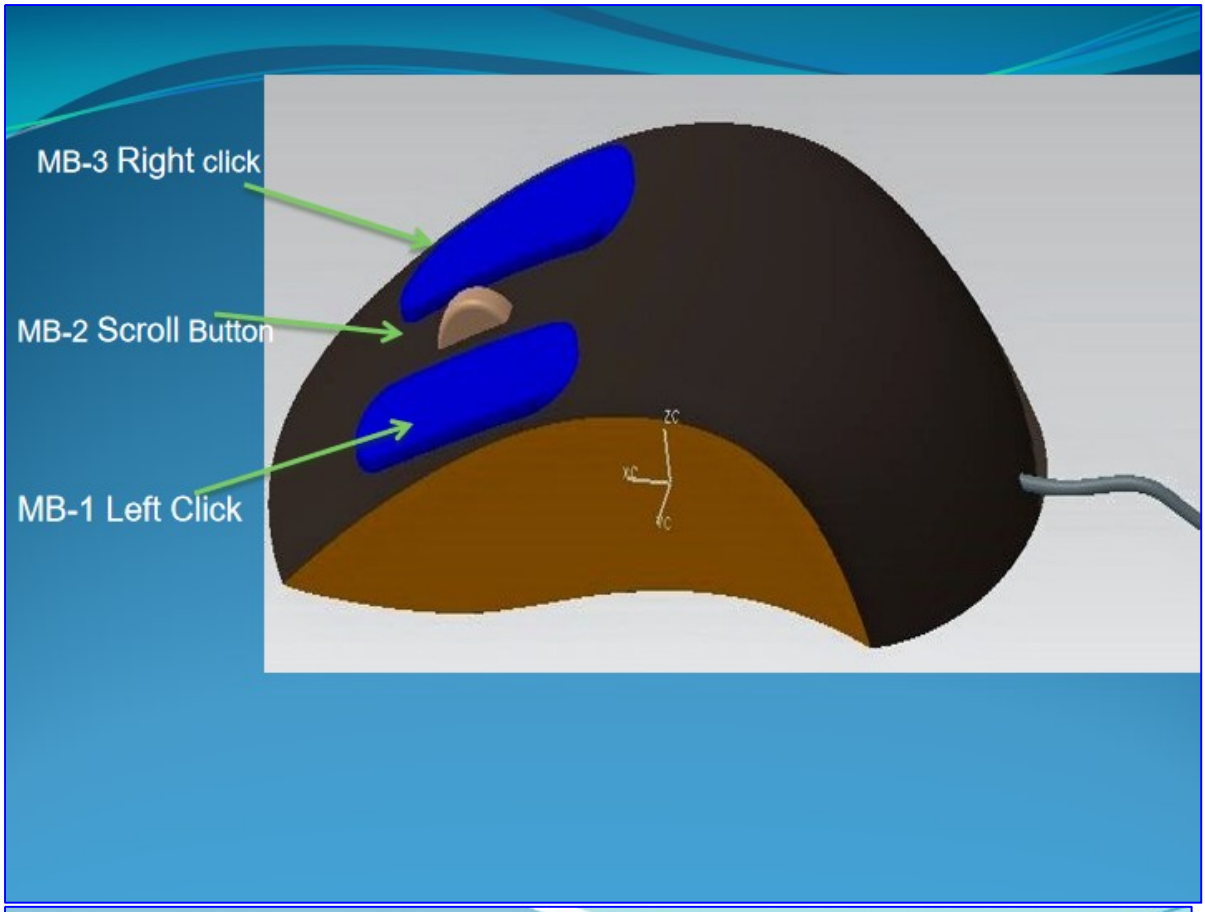
- Limits
  - Limits ↵
    - Specify Lower left corner : 0,0 ↵(X,Y)
    - Specify Right upper corner : 100',100' ↵
    - Z ↵(Zoom) , A ↵(All) (FIT TO SCREEN)

- Selection Method:
  - Cross Selection
  - Window Selection
  - Spot Selection



- Mouse Control:
  - MB1
    - Select Button
  - MB2
    - Pan (continuous press)
    - Zoom out & zoom in (scroll)
  - MB3
    - Pop-up Menu





TOOGLE KEYS

1. GRID MODE(F7) : To show graphical display.
2. SNAP MODE (F9): To take reference of graphical display.
3. ORTHO MODE (F8): To draw Horizontally & vertically straight line.
4. OBJECT SNAP/ O-SNAP MODE (F3): to show reference points of drawings.
5. OBJECT SNAP TRACKING (F11):To take reference line/ imaginary line from particular reference point.
6. POLAR MODE (F10): To draw angular lines.
7. DYNAMIC INPUT (F12): To draw at a time straight & angular lines.
8. LINE WEIGHT DISPLAY(LWD): To show line thickness.

- Line
  - L ↵
    - Specify First Point
    - give distance value ↵
    - Or (Click on next Point)

  Polyline :
    - pl ↵
    - Specify First Point
    - give distance value ↵
    - Or (Click on next Point)
- Circle
  - C ↵
    - Click Center Point
    - Specify Radius value ↵
    - OR D ↵ (for Diameter)
    - Specify diameter value ↵
- Undo
  - Ctrl + Z
- Redo
  - Ctrl + Y
- Save
  - Ctrl + S

- Offset
  - O ↵
  - Specify Offset Distance ↵
  - Select object
  - specify distension / direction
- Trim
  - Tr ↵↵
  - Select the un necessary parts
  - **Note : *profiles must be intersected.***
- Extend
  - Ex ↵↵
  - Select the line to extend
  - **Note : *There must be a boundary.***

TEXT

Single Line Text

- For Single line Text
  - Dt ↵
  - Specify Start point
  - Specify text height
  - Specify rotation angle of text (0=For Horizontal text & 90= For Vertical text)
  - Type the text

  Note: Double ↵ to terminate the command

Multiline Text

- For Multiline Text
  - Mt↵
  - Specify first corner for text window
  - H↵ (Height of text)
  - W↵ (width of the writing space)
  - Write the required text
  - Press "Close Text Editor" to terminate from command.

  Note : We can apply all text editing tools as we do in Word files

WORKSHEET-3

5.6 Projection of Lines

The shortest distance between two points is called a straight line. The projectors of a straight line are drawn therefore by joining the projections of its end points. The possible projections of straight lines with respect to V.P and H.P in the first quadrant are as follows:

1. Perpendicular to one plane and parallel to the other.
2. Parallel to both the planes.
3. Parallel to one plane and inclined to the other.
4. Inclined to both the planes.

1. Line perpendicular to H.P and parallel to V.P

The pictorial view of a stright line AB in the **First Quadrant** is shown in Fig.5.16a.

1. Looking from the front; the front view of AB, which is parallel to V.P and marked, $\mathbf{a'b'}$, is obtained. True length of AB = $\mathbf{a'b'}$.
2. Looking from the top; the top view of AB, which is perpendicular to H.P is obtained **a** and **b** coincide.
3. The Position of the line AB and its projections on H.P. and V.P are shown in Fig.5.16b.
4. The H.P is rotated through 90° in clock wise direction as shown in Fig.5.16b.
5. The projection of the line on V.P which is the front view and the projection on H.P, the top view are shown in Fig.5.16c.

Note : Only Fig.5.16c is drawn on the drawing sheet as a solution.

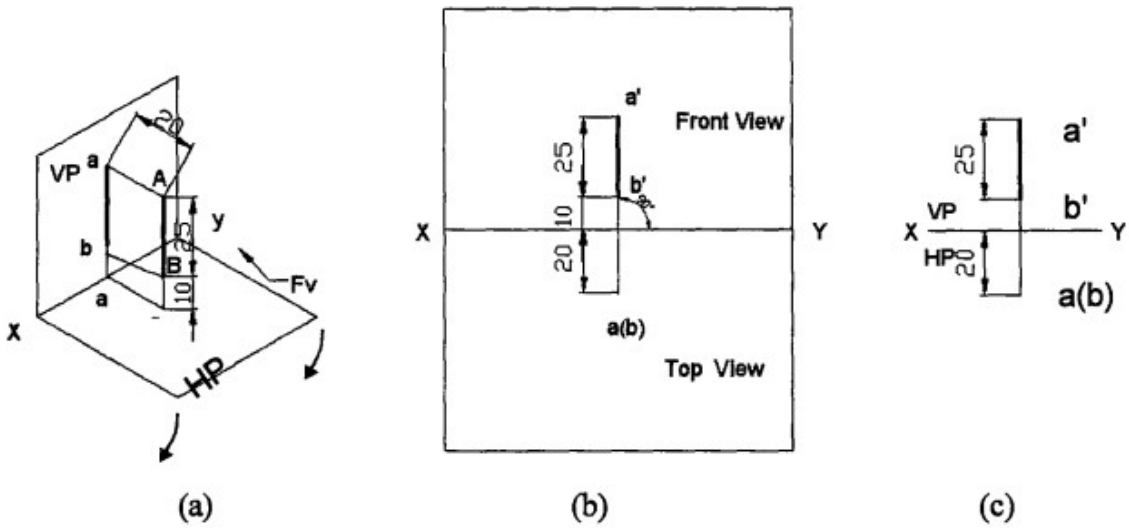
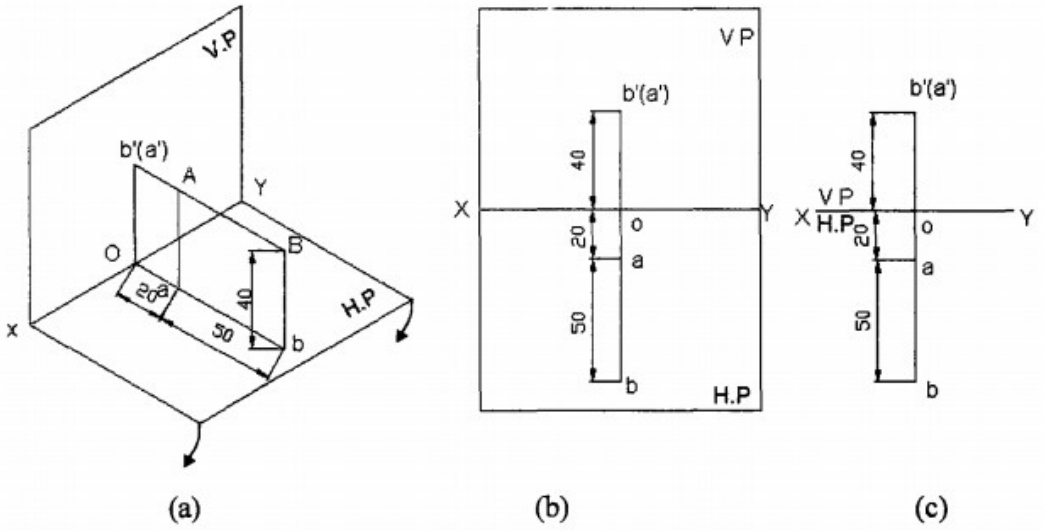


Fig. 5.16 Line perpendicular to H.P and parallel to V.P.

1. Line perpendicular to V.P and parallel to H.P.

Problem : *A line AB 50 mm long is perpendicular to V.P and parallel to H.P. Its end A is 20 mm in front of V.P and the line is 40 mm above H.P. Draw the projectons of the line.*

Solution (Fig. 5.17) : The line is parallel to H.P. Therefore the true length of the line is seen in the top view. So, top view is drawn first.



(a) (b) (c)

Fig. 5.17 Line perpendicular V.P and parallel to H.P.

1. Draw xy line and draw a projector at any point on it.
2. Point A is 20 mm in front of V.P. Mark **a** which is the top view of A at a distance of 20 mm below xy on the projector.
3. Mark the point **b** on the same projector at a distance of 50 mm below **a. ab** is the top view which is true length of AB.
4. To obtain the front view; mark $\mathbf{b}^{\prime}$ at a distance 40mm above xy line on the same projector.
5. The line AB is perpendicular to V.P. So, the front view of the line will be a point. Point A is hidden by B. Hence the front view is marked as $\mathbf{b}^{\prime}$ $(\mathbf{a}^{\prime})$. $\mathbf{b}^{\prime}$ coincides with $\mathbf{a}^{\prime}$.
6. The final projections are shown in Fig.5.17c.

2. Line parallel to both the planes

Problem : *A line CD 30 mm long is parallel to both the planes. The line is 40 mm above H.P and 20 mm in front of V.P.Draw its projection.*

Solution **:** (Fig.5.18)

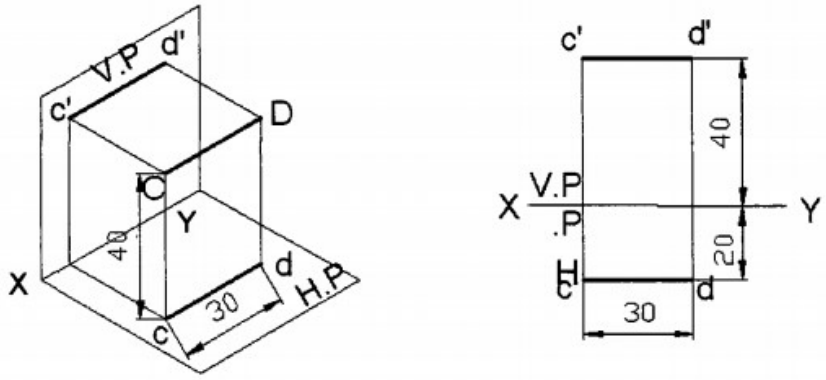


Fig. 5.18 Line Parallel to both the Planes

1. Draw the xy line and draw a projector at any point on it.
2. To obtain the front view mark **c'** at a distance of 40mm abvoe xy (H.P.). The line CD is parallel to both the planes. Front view is true lenght and is parallel to xy. Draw **c' d'** parallel to xy such that **c' d'** = CD = 30 mm, which is the true length.
3. To obtain the top view; the line is also parallel to V.P and 20 mm in front of V.P. Therefore on the projector from **c'**, mark **c** at distance 20 mm below xy line.
4. Top view is also true length and parallel to xy. Hence, **cd** parallel to xy such that **cd**=CD=30mm is the true length.(Fig.5.18).

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

Problem : *A line AB 40 mm long is parallel to V.P and inclined at an angle of 30° to H.P. The end A is 15 mm above H.P and 20 mm in front of V.P. Draw the projections of the line.*

Solution **:** (Fig.5.19)

1. A is 15 mm above H.P mark **a'**, 15 mm above xy.

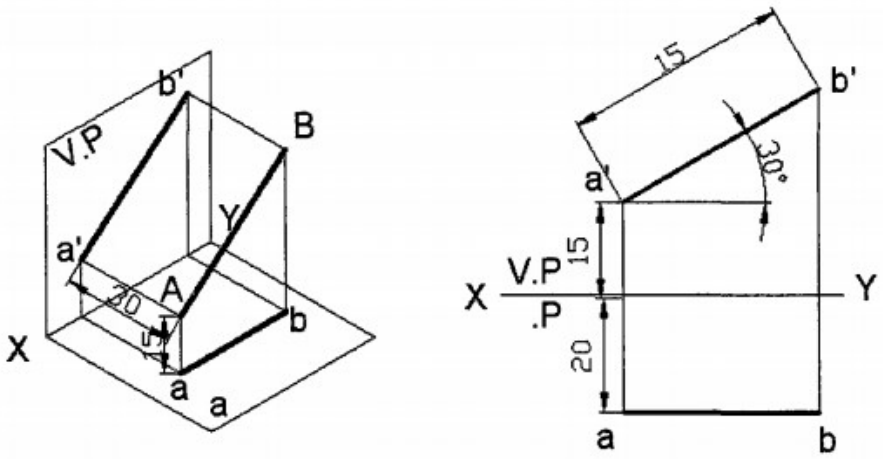


Fig. 5.19 Line parallel to V.P and inclined to H.P.

2. A is 20 mm in front of V.P. Hence mark **a** 20 mm below xy.
3. To obtain the front view **a' b'**; as AB is parallel to V.P and inclined at an angle θ to H.P, **a'b'** will be equal to its **true length** and inclined at an angle of 30° to H.P. Therefore draw a line from **a'** at an angle 30° to xy and mark **b'** such taht **a' b'** = 40 mm = true length.
4. To obtain the top view ab; since the line is inclined to H.P its projection on H.P (its top veiw) is reduced in length. From **b'** draw a projector to intersect the horizontal line drawn from **a** at **b**. **ab** is the top view of AB.

Note :

1. Inclination of line with the H.P is always denoted as θ.
2. When a line is parallel to V.P and inclined at an angle of θ to H.P, this inclination is seen in the front view and θ indicates always the true inclination with H.P. Hence, front view is drawn first to get the true length of the line.

Problem : *Draw the projections of straight line AB 60 mm long parallel to H.P and inclined at an angle of 40° to V.P. The end A is 30 mm above H.P. and 20 mm in front of V.P.*

Solution **:** (Fig.5.20)

1. A is 30 mm above H.P, mark **a'**, 30 mm above xy.

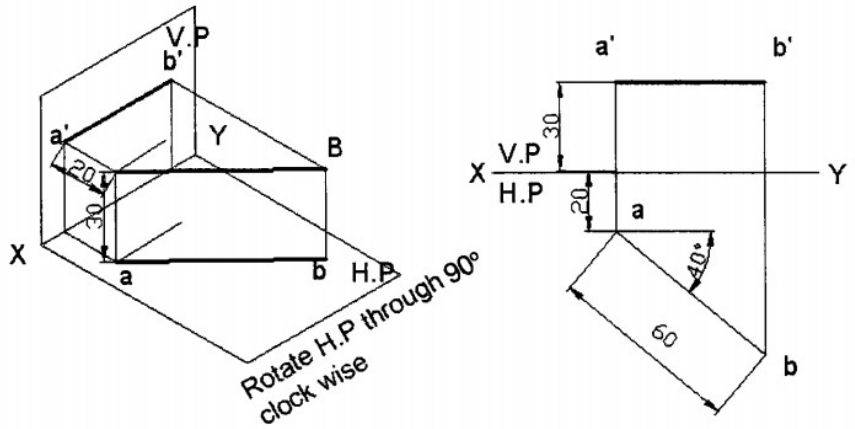


Fig. 5.20 Line Parallel to H.P and Inclined to V.P.

2. A is 20 mm in front of V.P, mark **a** 20 mm below xy.
3. To obtain the top view; as AB is praallel to H.P and inclined at an angle ϕ to V.P, **ab** will be equal to the true length of AB, and inclined at angle ϕ to xy. Therefore, draw a line from **a** at 40° to xy and mark **b** such that **ab**=60 mm true length.
4. To obtain the front view **a'b'**, since the line is inclined to V.P its projection on V.P i.e., the front view will be reduced in length. Draw from **b** a projector to intersect the horizontal line drawn from **a** at **b'**. **a'b'** is the front view of AB.

Note :

1. Inclination of a line with V.P is always denoted by ϕ.
2. when a line is paralel to H.P and inclined at an angle of ϕ to V.P, this inclination ϕ is seen in the top view and hence top view is drawn first to get the true length of the line.

PROJECTION OF LINES

Q1. Draw the projections of a 70mm long straight line AB, when it is
(a) Parallel to and 25 mm above the H.P and lying in the V.P.
(b) Perpendicular to the H.P 25 mm behind the V.P and its one End 10mm above the H.P
(c) Perpendicular to the V.P in the H.P and its one end in the V.P
(d) Inclined at 35° to the H.P with one end 20mm above it, And parallel to and 25 mm in front of the V.P.

Q2. A line CD 30 mm long is parallel to both the planes (V.P and H.P). the line is 40 mm above the H.P and 25 mm in front of V.P. Draw its projections

Q3. Draw the projection of a straight in line CD 50mm V.P. The End C is 10mm in front of V.P and D is 30mm in front of V.P And the line is 15mm above H.P.

Q4. A line EF 40mm long is in the V.P and inclined to H.P. The top View measures 30mm the end E is 10mm above the H.P. Draw the projections of the line and determines its Inclination with H.P.

WORKSHEET-4

A line AB, 70mm long, has its end A 15mm above HP and 20mm in front of VP. It is inclined at 30° to HP and 45°to VP. Draw its projections and mark its traces

Steps :

- Draw XY
- Mark point a' 15 mm above XY and a 20 mm below XY
- Draw a line a'b1' = 70 mm inclined to XY @ 30 deg
- Draw a line ab2 = 70 mm inclined to XY @ 45 deg
- Draw locus of points a', b1',a,b2.
- Draw line from point b1' which touches locus of a @ b1
- Draw line from point b2 which touches locus of a' @ b2'
- Draw arc , taking a' as centre and a'b2' as radius that cuts locus of b1' @ b'

Draw arc , that cuts locus of b2 @ b

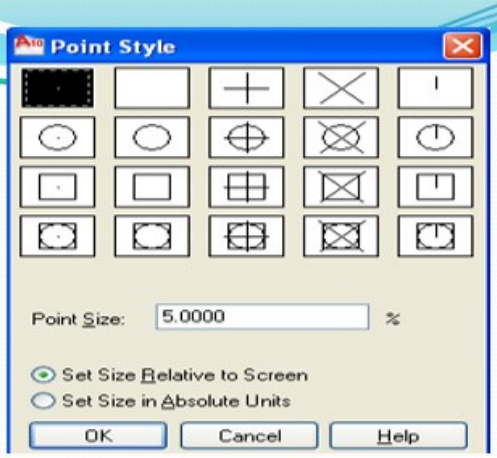
Similar to Q3 : A line AB , 70 (100) mm long , has its end A in HP & end B in VP.The line is inclined @ 45 (40) deg to the HP & 40 (50) deg to VP. Measure the FVL, & TVL.

Draw XY
Mark a point A1 on XY
Draw a line A1B=70 mm @45 deg to XY
Draw a line A1B1=70 mm @40 deg to below XY
Extend point B till XY & name it b
Extend point B1 till XY & name it b1
Draw locus of B1
Take b as centre and A1b as radius , cut an arc on the locus of B1 and name it a
Extend a upwards till it touches XY @ a'
Join a' & B, rename B as "b"

- The top view of a 75mm long line AB measures 65mm, while its front view measures 50mm. Its one end A is in HP and12mm in front of VP. Draw the projections of AB and determine its inclination with HP and VP.

Mark point a' on XY and a 12 below XY
Draw a line ab1=65 mm
Extend b1 in upward direction
Draw a'b1'=75 mm on the extended line
Taking a' as centre and 50 radius cut an arc on locus of b1' at b'
Rotate a'b' onto XY and extend it downwards direction
Cut an arc taking a as centre and 75 mm radius on above extended line and name it b2
Draw locus of b2
Cut an arc taking a as centre and 65 mm radius at locus of b2 and call it b
Join ab

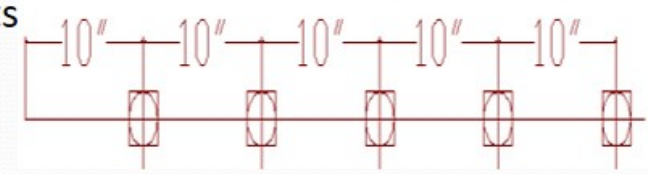
POINT STYLE



- Ddptype ↵
  - Select point style
  - Change point size
  - Set size relative to screen or set size in absolute units
  - OK

POINT & POINT STYLE

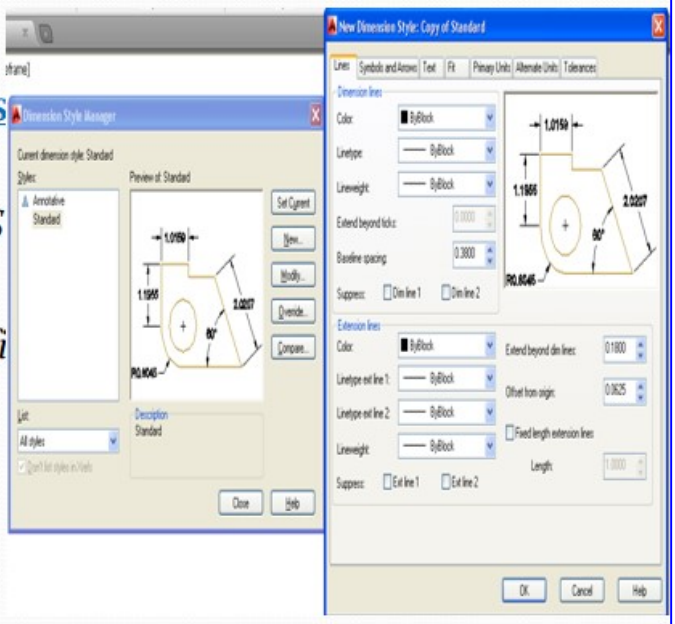
- **POINT: Divide**
  - Div ↵
    - Select object
    - Give no of segments



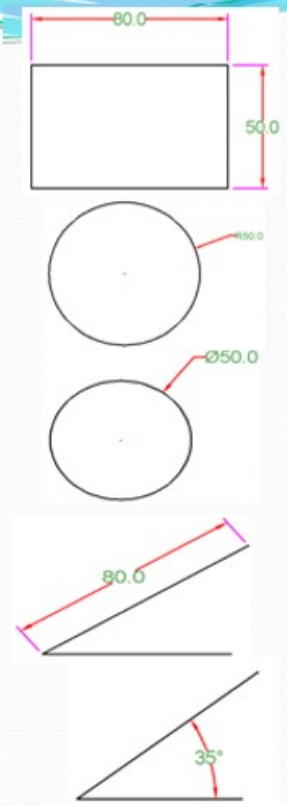
- POINT: Measure
  - Me ↵
    - Select object
    - Give length of segment

Dimension Style

- To Modify the Dimension S
- *Command: D ↵*
- *Select the Dimension S*
- *Click Modify*
- *change the style modifi*
- *Ok*
- *Set current*
- *Close*

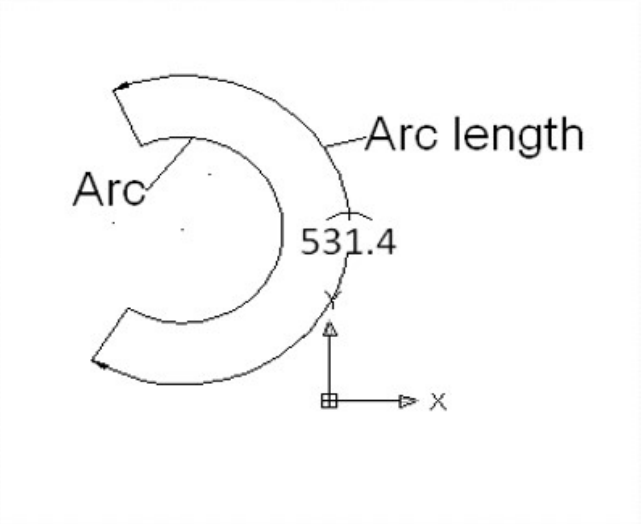


- Dimension Style
  - Linear
  - Radius
  - Diameter
  - Aligned
  - Angular



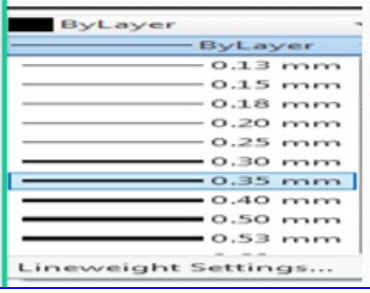
ARC LENGTH

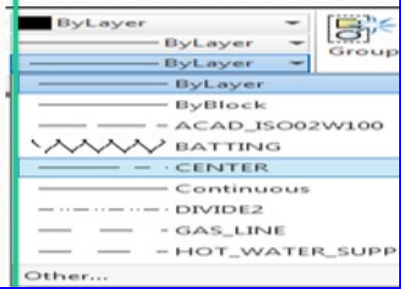
- Menu bar → Dimension → Arc length
- Select Arc → Select arc length dimension location



Line Properties (Ctrl+1)

Line Color line	Line weight	Line type
❖Draw the object ↦then select object ↦ select line color ↦show the difference color choose the any color ↦ Esc	❖Draw the object ↦then select object ↦ select line weight ↦ choose the line weight ↦ Esc ↦then go to status bar select LWT	• Select line type ↦other ↦load ↦press ctrl select ↦according to use line type ↦ ok ↦ok • Draw the object ↦then select object ↦ choose the line type ↦press ,ctrl+1 ↦scale type value ↦close ↦ Esc





Engineering Graphics Ex-4

LINE INCLIND TO BOTH THE PLANES

Q 1. A line CD 80 mm long is inclined at an angle 30° to H.P and 45° V.P. The point C is 20 mm above the H.P and 30 mm in front of V.P. Draw the projection of the straight line.

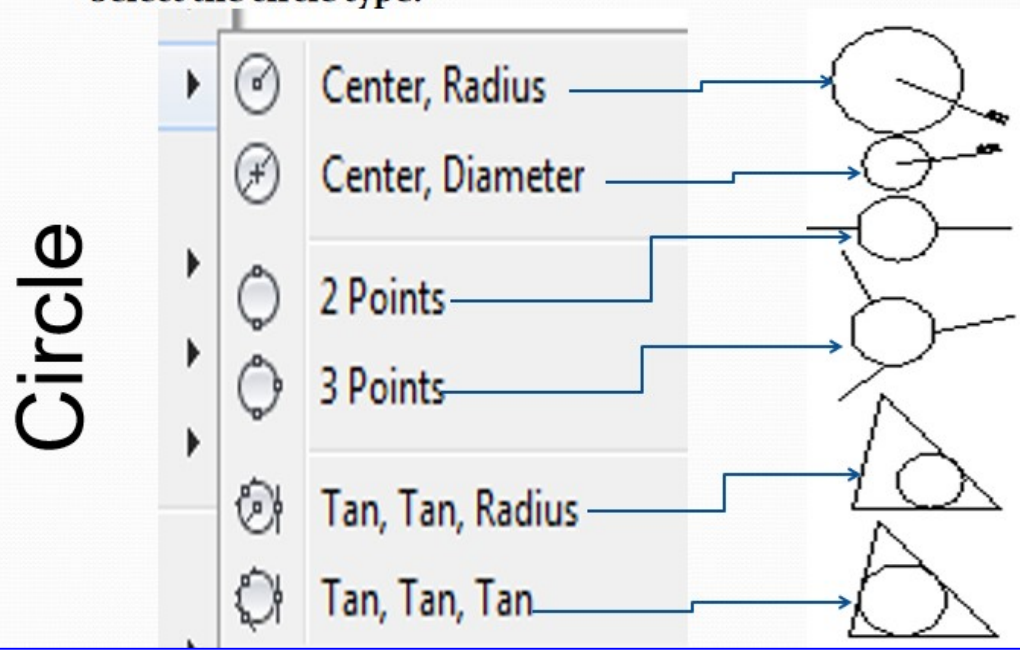
Q 2. A line measuring 75 mm long has one of its ends 50 mm in front of V.P and 15 mm above H.P. The top view of the line is 50 mm long and in front of V.P. The other end of the line is 15 mm in front of V.P.

Q 3. Draw the projection of the line AB, 100 mm long , when one of its Ends are touching the V.P and the other end touching the H.P. The Angle of inclination with H.P and V.P are 40° and 50° respectively.

Q 4. A line LM 70 mm long has its end L 10 mm above H.P and 15 mm in Front of V.P. Its top view and front view measure 60 mm and 40 mm Respectively. Draw the projections of the line and determine its Inclinations with H.P and V.P.

WORKSHEET-5

- **Types of Circle : C ↵**
  - **Select the circle type:-**

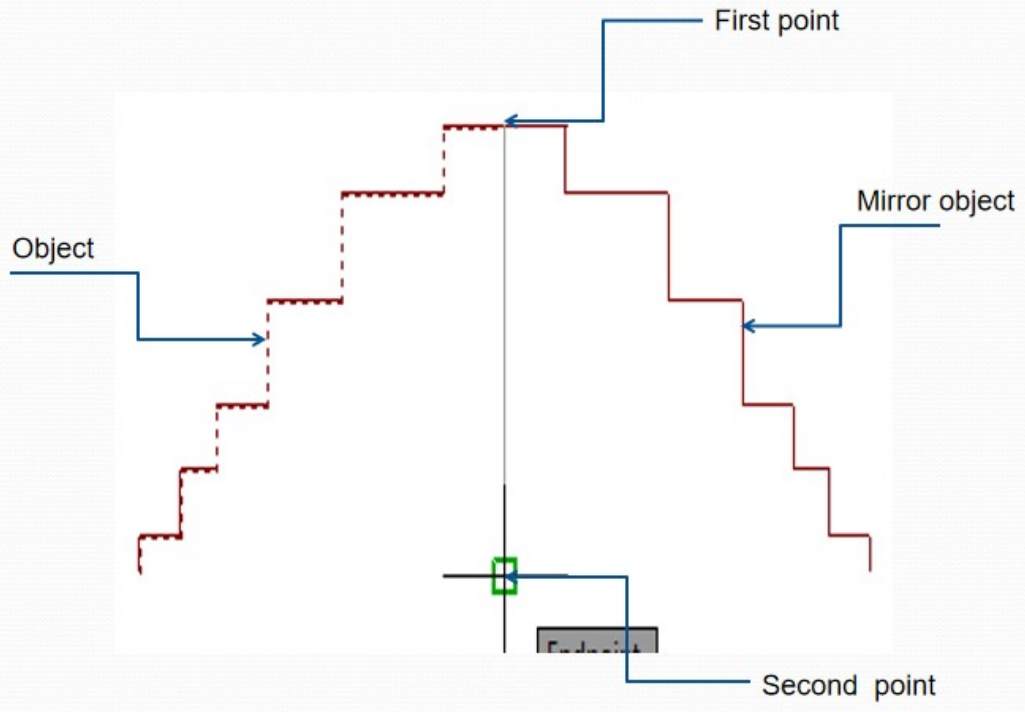


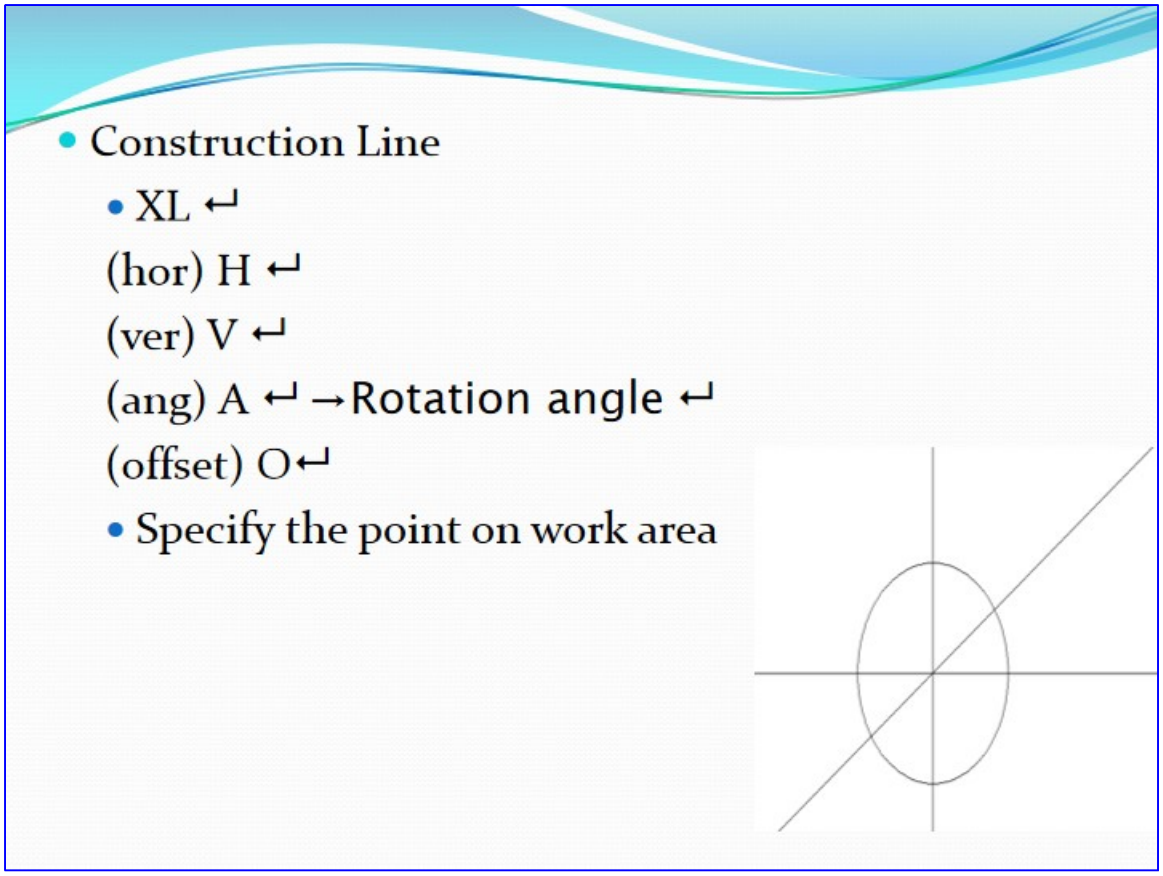
- Rectangle
  - Rec ↵
    - Specify 1st Corner for Rectangle
    - D ↵ (For Dimension)
    - Define the length value ↵
    - Define the width value ↵
    - Click on screen place the Rectangle

- Move
  - M ↵
  - Select object ↵
    - Select base point
    - Specify the destination point
- Rotate
  - Ro ↵
    - Select object ↵
    - Select Base Point
    - Specify Rotation Angle ↵
- Copy
  - Co ↵
    - Select Object ↵
    - Select Base Point
    - Specify the destination point

MIRROR

- Mi ↵
- Select object ↵
- Select first point of mirror line
- Select second point on mirror line
- Delete the source object (Y/N) ↵





P

ROJECTION OF PLANES

Projection of Planes

A plane figure has two dimensions viz. the length and breadth. It may be of any shape such as triangular, square, pentagonal, hexagonal, circular etc. The possible orientations of the planes with
respect to the principle planes H.P and v.p of projection are:

1.Plane parallel to one of the principal planes and perpendincular to the other,
2. Plane perpendicular to both the principal planes,
3. Plane inclined to one of the principal planes and perpendclicular to the other,
4. Plane inclined to both the principal planes.

Plane parallel to one of the principal planes and perpendicular to the other When a plane is parallel to V.P the front view shows the true shape of the plane. The top view appears as a line parallel to xy. Figure 5.23a shows the projections of a square plane ABCD, when it is parallel to V.P and perpendicular to H.P. The distances of one of the edges above H.P and from the V.P are denoted by d1 and d2 respectively. Figure 5.23b shows the projections of the plane. Figure 5.23c shows the projections of the plane, when its edges are equally inclined to H.P. Figure 5.24 shows the projections of a circular plane, parallel to H.P and perpendicular to V.P.

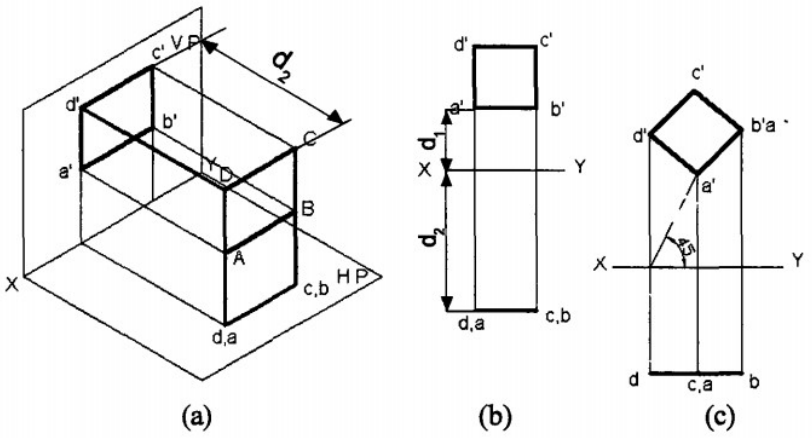


Fig. 5.23

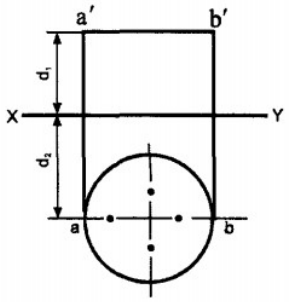


Fig. 5.24

Plane perpendicular to both H.P and v.P. When a plane is perpendicular to both H.P. and V.P, the projections of the plane appear as straight lines. Figure 5.25 shows the projections of a rectangular plane ABCD, when one of its longer edges is parallel to H.P. Here, the lengths of the front and top views are equal to the true lengths of the edges.

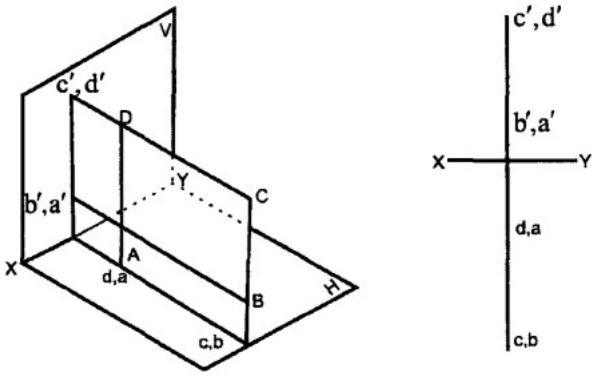


Fig. 5.25

Plane inclined to one of the principal planes and perpendicular to the other When a plane is inclined to one plane and perpendicular to the other, the projections are obtained in two stages.

Problem:

(i) Projections of a pentagonal plane ABCDE, inclined at ~ to H.P and perpendicular to v.p and

resting on one of its edges on H.P.

Constructon : (Fig.5.26)

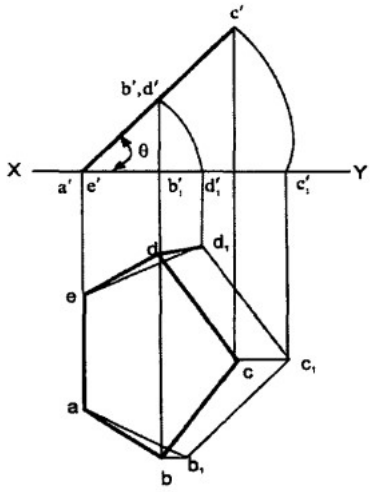


Fig. 5.26

Problem: A regular pentagon ABCDE, of side 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 shown its traces when its comer nearest to v.p is 15 mm from it.

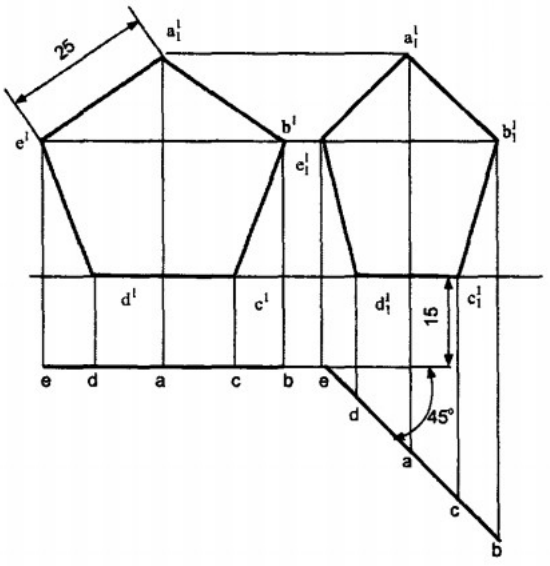


Fig. 5.47

Plane Parallel to Plane Parallel to VP

Problem:

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 45^0 to the HP

Visualized position of surface plane Picture:

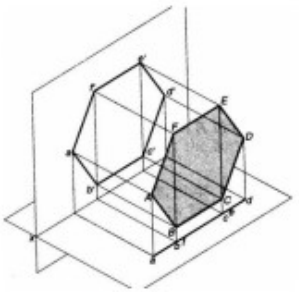


Figure 3.9(a)

Solution:

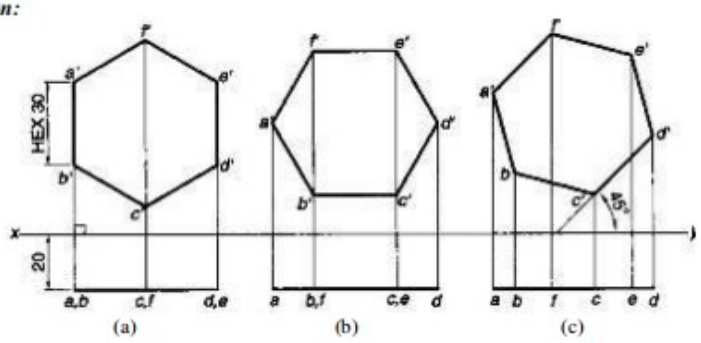


Figure 3.9(b)

Plane is inclined to HP and Perpendicular to VP

Problem:

A Pentagonal plane with a 30mm side has an edge on the HP, the surface of the Plane is inclined at 45^0 to the HP. Draw it's Projections?

Visualized position of surface plane Picture:

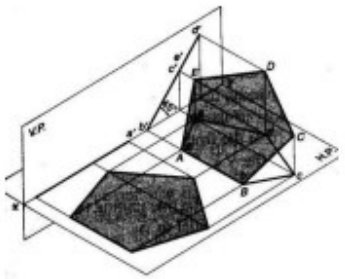


Figure 3.10(a)

Solution:

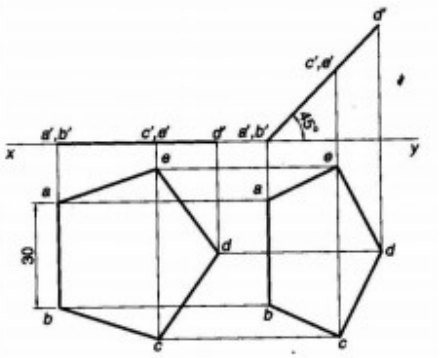


Figure 3.10(b)

Figure 3.11(b)

Problem:

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 45^0 to the VP. And perpendicular to the HP Draw It's Projections?

Solution:

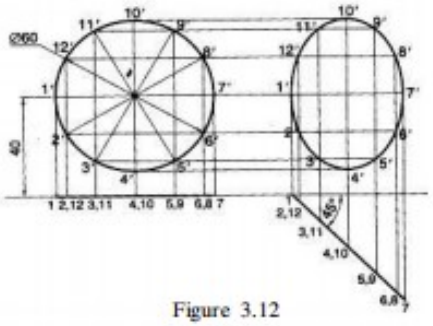


Figure 3.12

PROJECTION OF PLANES

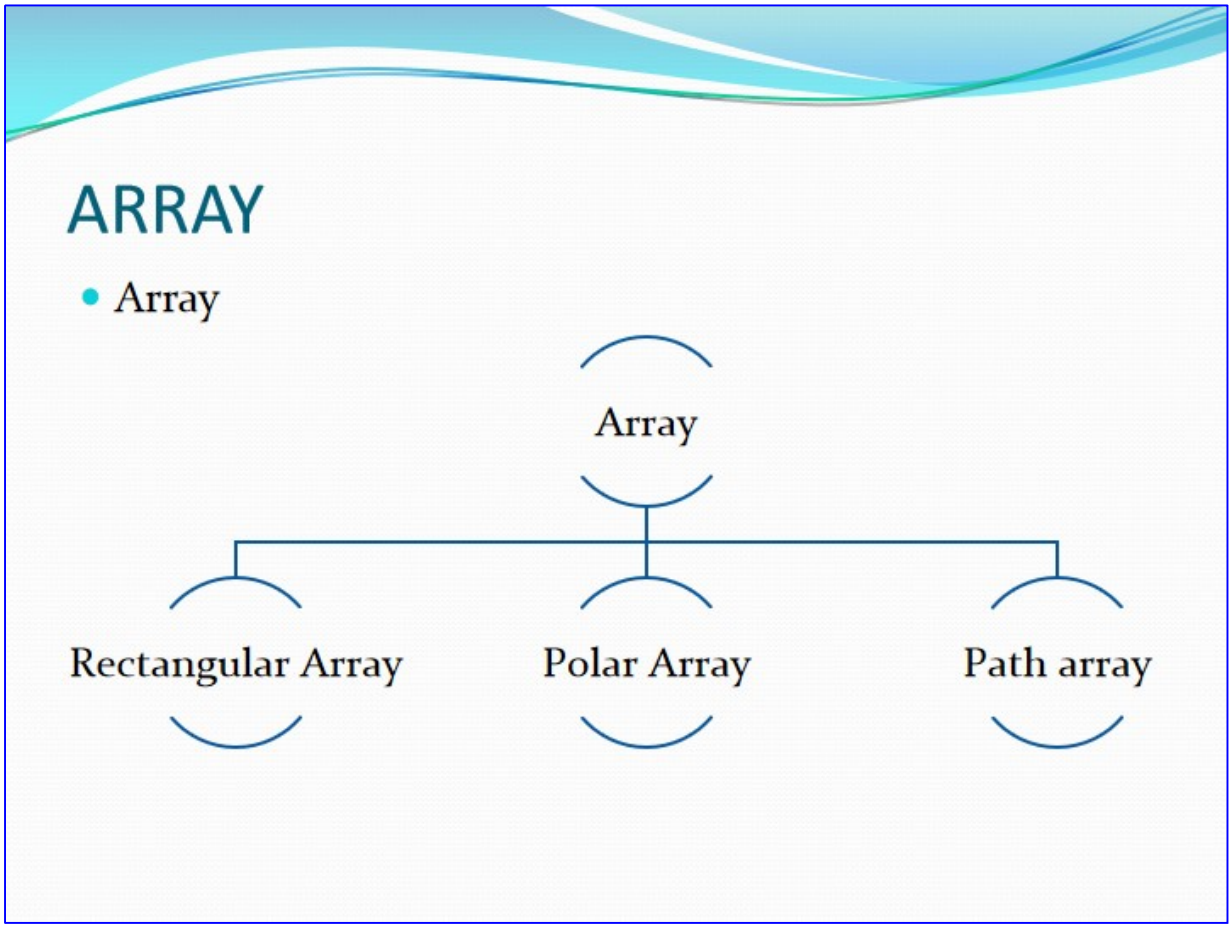
Q1. A pentagonal plane ABCDE of 30mm side is parallel to and 10mm above H.P. Its one side is parallel to and in front of V.P. The corner opposite to this side is 70mm in front of V.P. Draw the projections of the plane.

Q2. A rectangular lane ABCD of 50mm x 20mm has its plane Perpendicular to V.P and inclined at 30° to H.P. its corner 'A' is 20mm above the H.P. and 15mm in front of V.P. Draw the Projections of the plane when the longer side is parallel to the V.P.

Q3. A hexagonal plane ABCDEF of 25mm side has its plane Perpendicular to H.P and inclined at 30° V.P. Its ne side is Parallel to and 10mm above of H.P. and 15 mm in front of V.P. Draw the projections.

Q4. Draw the projections of a circular plane of 50mm diameter Having its plane vertical and inclined at 30° to the V.P. Its Center is 30mm above the H.P and 30mm in front of the V.P.

WORKSHEET 6



ARRAY

FOR RECTANGULAR ARRAY

- Ar ↵
- Select the object ↵
- Select the type of array (Rectangular) or R ↵
- Specify no. of Rows ↵
- Specify no. of columns ↵
- Specify Row offset distance ↵
- Specify columns offset distance ↵
- close

ARRAY

FOR POLAR ARRAY

- Ar ↵
- Select the object ↵
- Select the type of array (Polar) for PO ↵
- Pick centre point
- Specify total no. of items
- Specify rotation angle or Angle to fill
- **close**

HATCH

- H↵
- Select Add pick point
- Click on object
- Select required pattern
- Change the hatch color, background color,
- change on angle,
- Change scale value according to requirement
- Close

6.1 Introduction

A solid has three dimensions, the length, breadth and thickness or height. A solid may be represented by orthographic views, the nuber 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) Polyhedra, and (ii) Solids of revolution

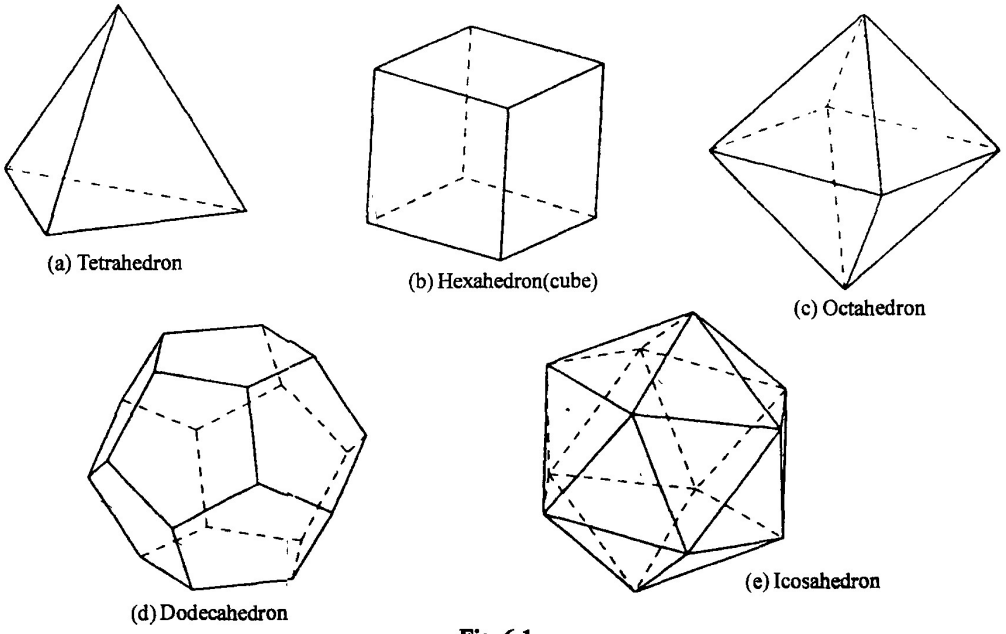
6.1.1 Polyhedra

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

(i) Regular polyhedra (ii) Prisms and (iii) Pyramids.

6.1.2 Regular Polyhedra

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



(a) Tetrahedron (b) Hexahedron(cube) (c) Octahedron

(d) Dodecahedron (e) Icosahedron

Fig. 6.1

(a) Tetrahedron: It consists of four equal faces, each one being a equilateral triangle.

(b) 'Hexa hedron(cube): It consists of six equal faces, each a square.

(c) Octahedron : It thas eight equal faces, each an equilateral triangle.

(d) Dodecahedron : It has twelve regular and equal pentagonal faces.

(e) Icosahedron : It has twenty equal, equilateral triangular faces.

6.2 Prisms

A prism is a polyhedron having two equal ends called the bases prallel to each other. The two bases are joined by faces, which are rectangular in shape. The imaginary line passing through the centres 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 (Fig.6.2) The nomenclature of the prism is given in Fig.6.3.

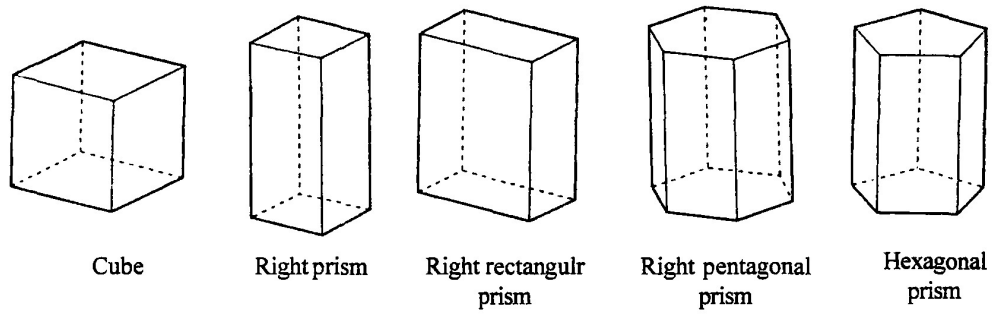


Fig. 6.2

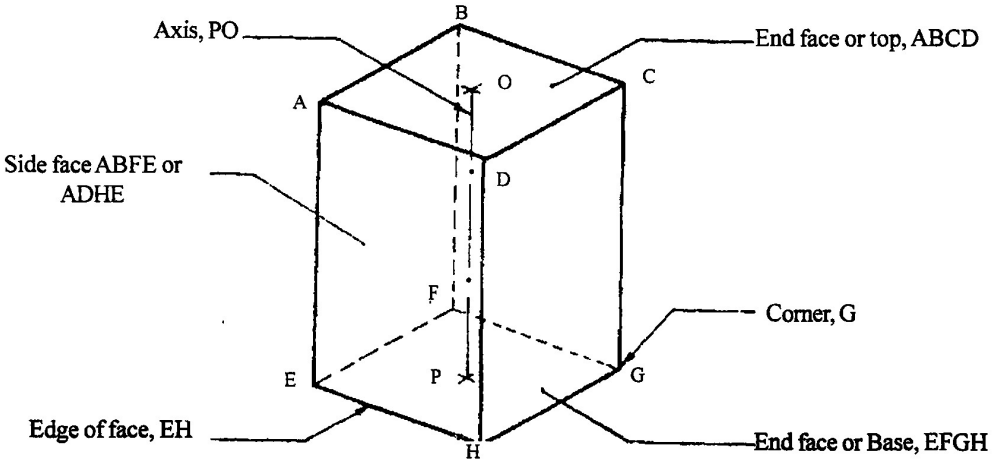


Fig. 6.3 Nomenclature of a Square Prism

6.3 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 pyromid 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 (Fig.6.4(a)). The nomenclature of a pyramind is shown in Fig.6.4(b).

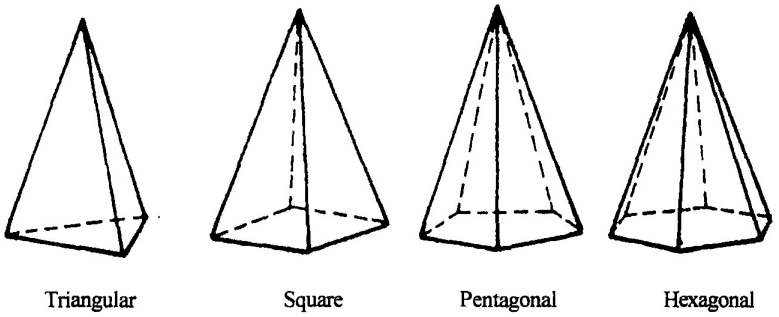


Fig. 6.4(a) Pyramids

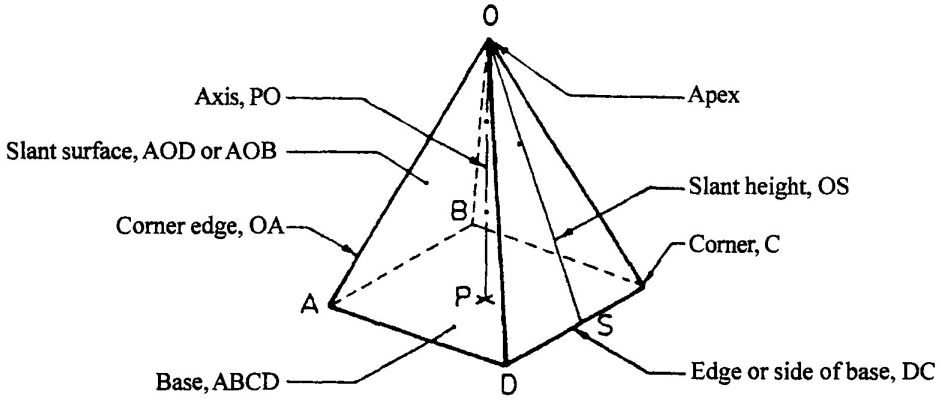


Fig. 6.4(b) Nomenclature of a Square Pyramid

6.4 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.

6.5 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

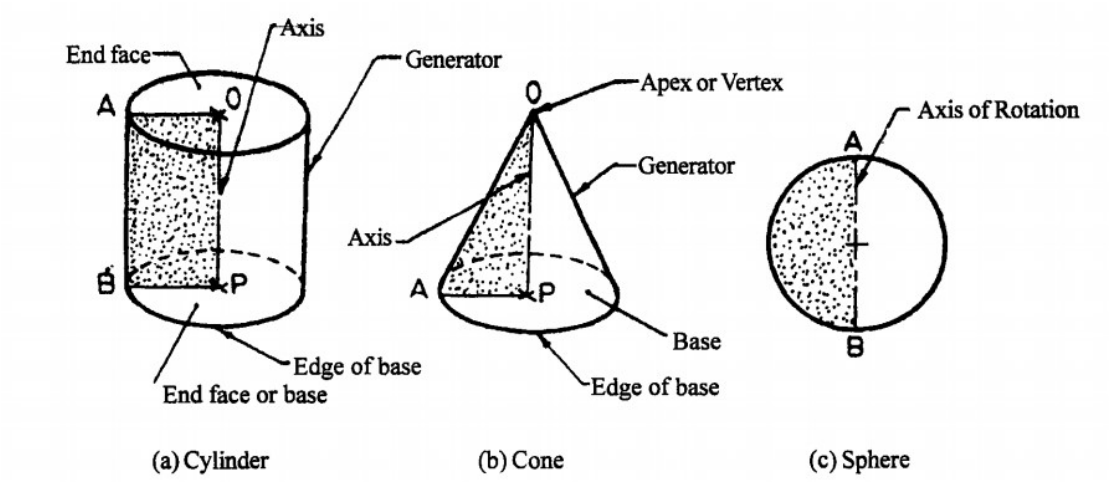


Fig. 6.5 Solids of Revolution

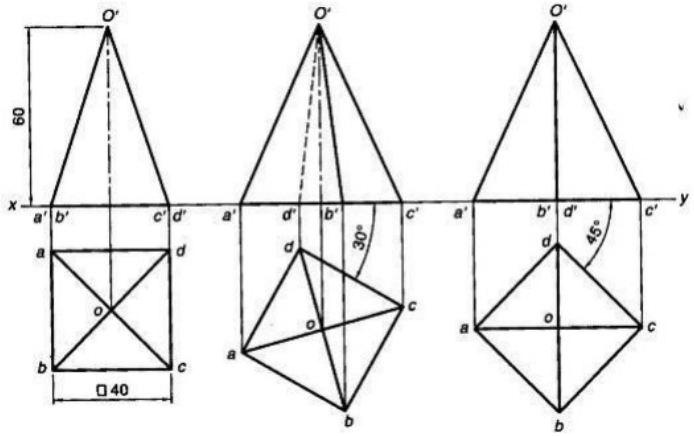
PRACTICE PROBLEM

1. Axis perpendicular to HP

Problem:

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 30^0 to the VP and (c) All the sides of base are equally inclined to the VP.

Solution:

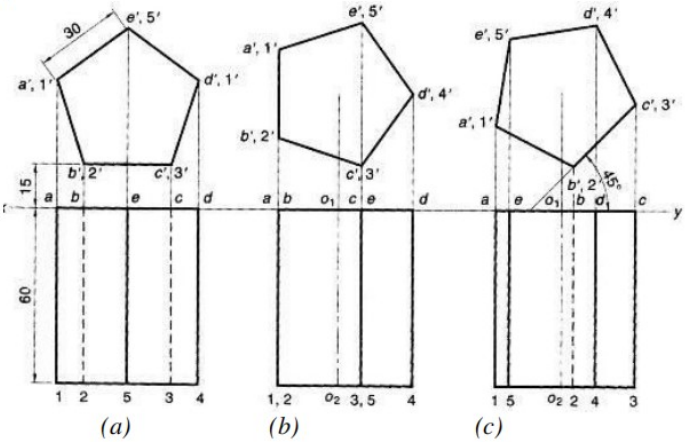


2. Axis perpendicular to VP

Problem:

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 45^0 to the HP

Solution:



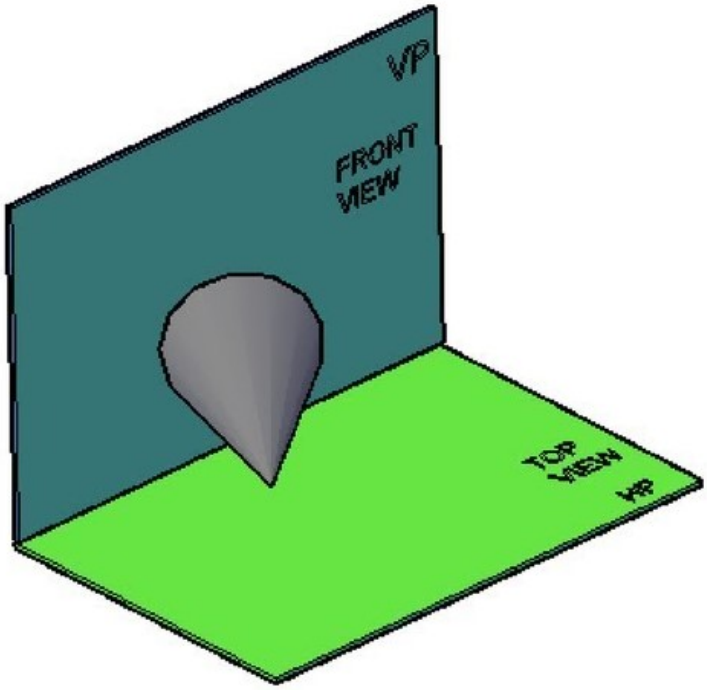


Figure 3.28

Problem:

A circular cone, 40 mm base diameter and 60 mm long axis is resting on HP, on one point of base circle such that it's axis makes 45^0 inclination with HP and 40^0 inclination with VP. Draw it's projections.

Solution:

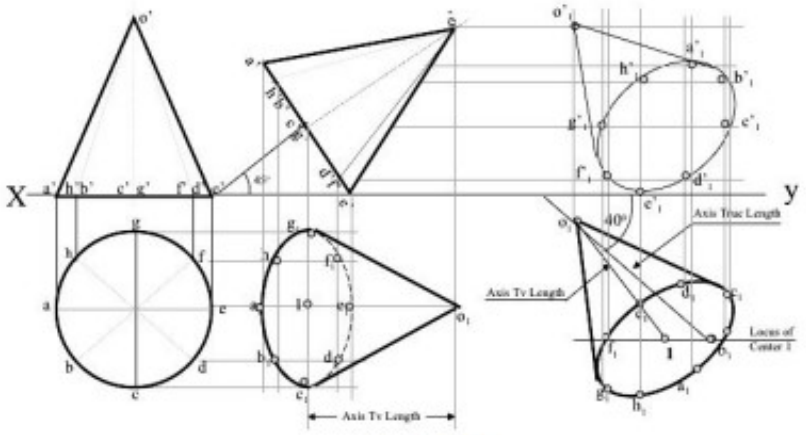


Figure 3.29

Problem:

A cylinder 40 mm diameter and 50 mm axis is resting on one point of a base circle on VP while it's axis makes 45^0 with VP and FV of the axis 35^0 with HP. Draw its projections.

Solution Steps:

Resting on VP on one point of base, means inclined to VP:

1. Assume it standing on VP
2. It's FV will show True Shape of base & top(circle)
3. Draw 40mm dia. Circle as FV & taking 50 mm axis project TV. (a Rectangle)
4. Name all points as shown in illustration.
5. Draw 2^{nd} TV making axis 45^0 to xy and project it's FV above xy.
6. Make visible lines dark and hidden dotted, as per the procedure.
7. Then construct remaining inclination with HP (FV of axis i.e. center line of view to xy as shown) & project final.

Solution:

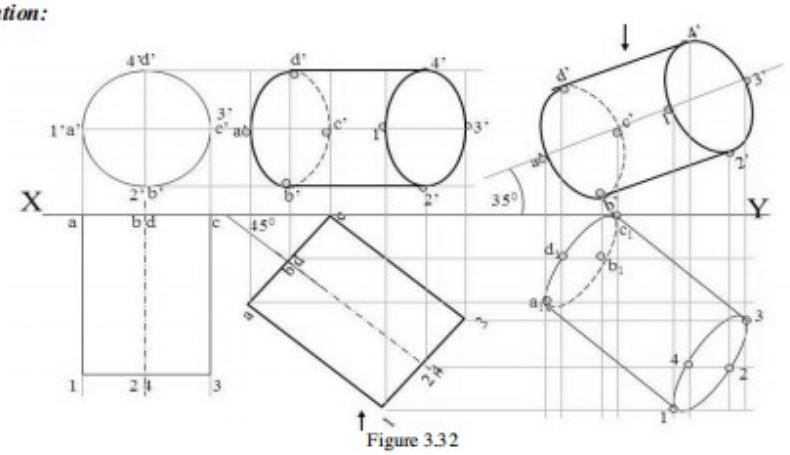


Figure 3.32

PROJECTION OF SOLIDS

Q1. Draw the projections of a cylinder of base 40mm diameter And axis 50mm long resting on its base on H.P. and axis 25mm in front of V.P.

Q2. Draw the projections of a right circular cone of base 40 mm Diameter and height 60mm long when one point on Circumference of base is touching V.P. Axis is 25 mm above and parallel H.P. and inclined to V.P at 45°

Q3. Draw the projections of regular pentagonal prism side of Base side 30mm and axis 60mm long, resting with its base on V.P . Such that one of its rectangular faces is parallel to And 10mm above H.P.

Q4. A regular hexagonal prism of base 25mm side and axis 60mm long is resting on one of its corner of the base on H.P. The axis of the solid is inclining at 45° to the H.P.

WORKSHEET -7

SECTIONS OF SOLIDS

ONE OF ENGINEERING APPLICATIONOF PROJECTION OF SOLIDS IS SECTION OF SOLIDS.

•Hidden features of an object are shown using dotted lines in their projected views

• When there are too many hidden features, it becomes difficult to visualize the object

• In such cases one usually shows a sectioned view of the solid - the view obtained by virtually cutting the solid by a plane called the section (cutting) plane and removing the part between the observer and the plane

SECTIONING A SOLID.

An object (here a 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.

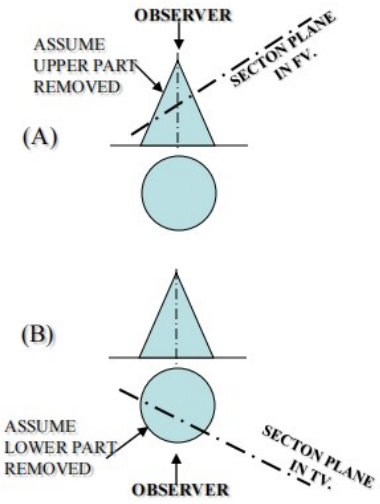
Two cutting actions means section planes are recommended.

A) Section Plane perpendicular to Vp and inclined to Hp.
(This is a definition of an Aux. Inclined Plane i.e. A.I.P.)
NOTE:- This section plane appears as a straight line in FV.

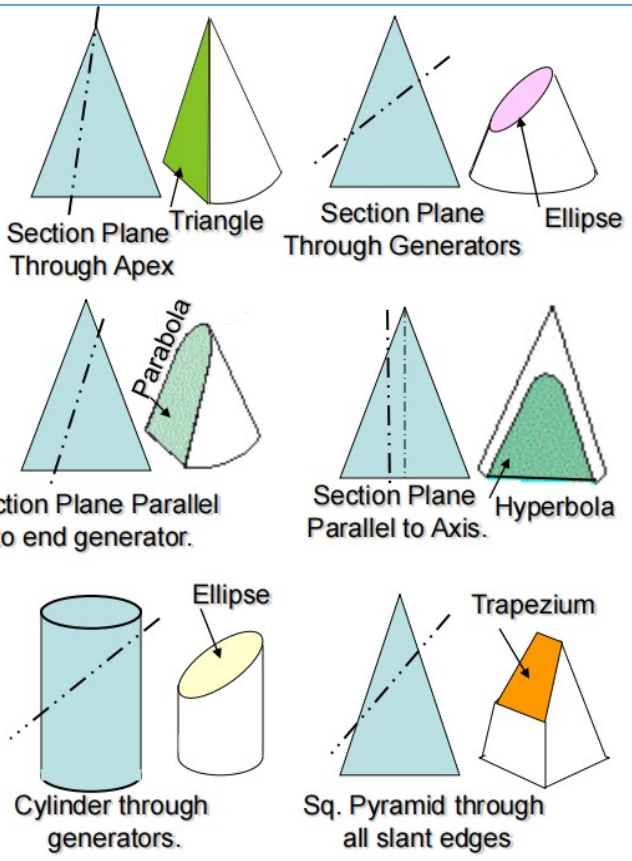
B) Section Plane perpendicular to Hp and inclined to Vp.
(This is a definition of an Aux. Vertical Plane i.e. A.V.P.)
NOTE:- This section plane appears as a straight line in TV.

Remember:-

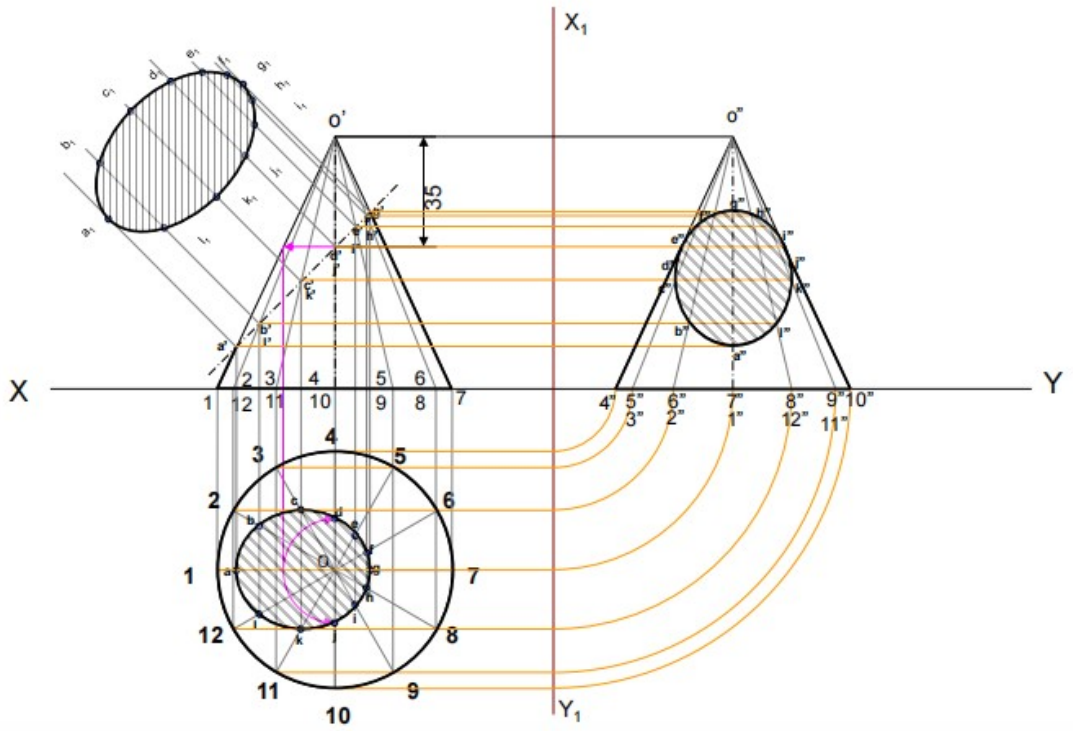
1. **After launching a section plane either in FV or TV, the part towards observer is assumed to be removed.**
2. **As far as possible the smaller part is assumed to be removed.**



Typical Section Planes & Typical Shapes Of Sections.



Q 4: A Cone base 75 mm diameter and axis 80 mm long is resting on its base on H.P. It is cut by a section plane perpendicular to the V.P., inclined at 45° to the H.P. and cutting the axis at a point 35 mm from the apex. Draw the front view, sectional top view, sectional side view and true shape of the section.



PROJECTION OF SOLIDS

Q1. Draw the projections of a cylinder of base 40mm diameter And axis 50mm long resting on its base on H.P. and axis 25mm in front of V.P.

Q2. Draw the projections of a right circular cone of base 40 mm Diameter and height 60mm long when one point on Circumference of base is touching V.P. Axis is 25 mm above and parallel H.P. and inclined to V.P at 45°

Q3. Draw the projections of regular pentagonal prism side of Base side 30mm and axis 60mm long, resting with its base on V.P . Such that one of its rectangular faces is parallel to And 10mm above H.P.

Q4. A regular hexagonal prism of base 25mm side and axis 60mm long is resting on one of its corner of the base on H.P. The axis of the solid is inclining at 45° to the H.P.

Engineering Graphics Ex-7

PROJECTION OF SOLIDS

Q.1. A pentagonal pyramid, side of base 30mm and axis 60mm long, rests with it's base on H.P. and one of the edges of its base is perpendicular to V.P. it is cut by a section plane perpendicular to V.P. and parallel to H.P. and cutting the axis at a point 35mm above the base .Draw the front and sectional top view of truncated pyramid.

Q2. A Right circular cone with diameter of base 50mm and axis 60mm long is resting on its base on H.P. and passing through the axis at a point 35mm above H.P. Draw the projections of the cut solid.

Q3. A cylinder having base diameter 45mm and height 55mm is resting on H.P. on its base .A section plane perpendicular to H.P and inclined to V.P. at 45° cuts it 10mm away from the axis. Draw the sectional elevation and plane.

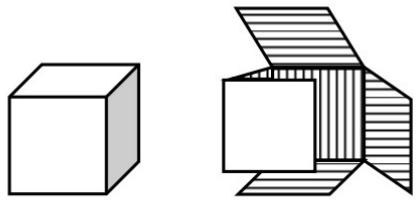
Q4. A hexagonal pyramid side of base 25mm and axis 55mmlong rests with its base on H.P. such that one of the edge of its base perpendicular to V.P. It is cut by a section plane perpendicular to H.P. inclined at 45° to V.P. and passing through the pyramid at a distance of 10mm from the axis. Draw the sectional front view and true shape of the section.

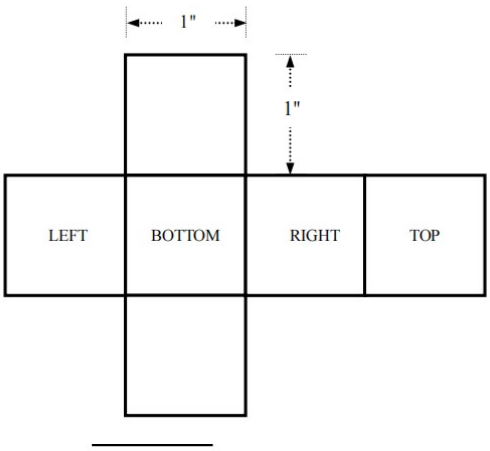
WORKSHEET -8

"The **development of 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." In other words, the development of a solid is the shape of a plain sheet that by proper folding could be converted into the shape of the concerned solid

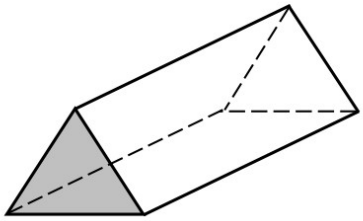
DEVELOPMENT OF SECTIONS

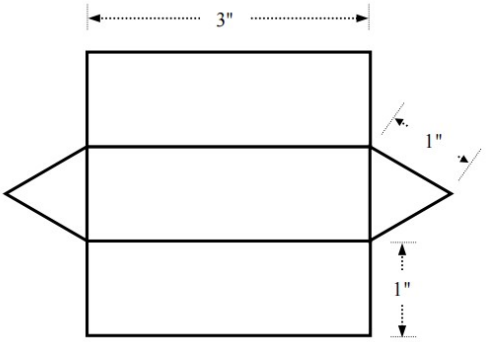
- **Develop the surfaces of the cube of 1"**



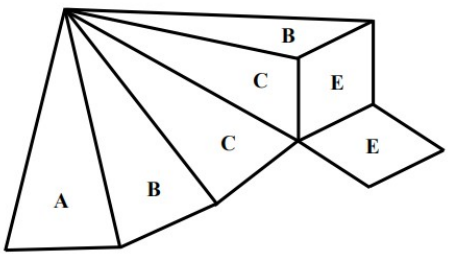


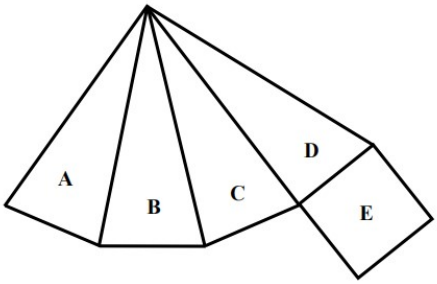
- **Develop the surfaces of a triangular prism**



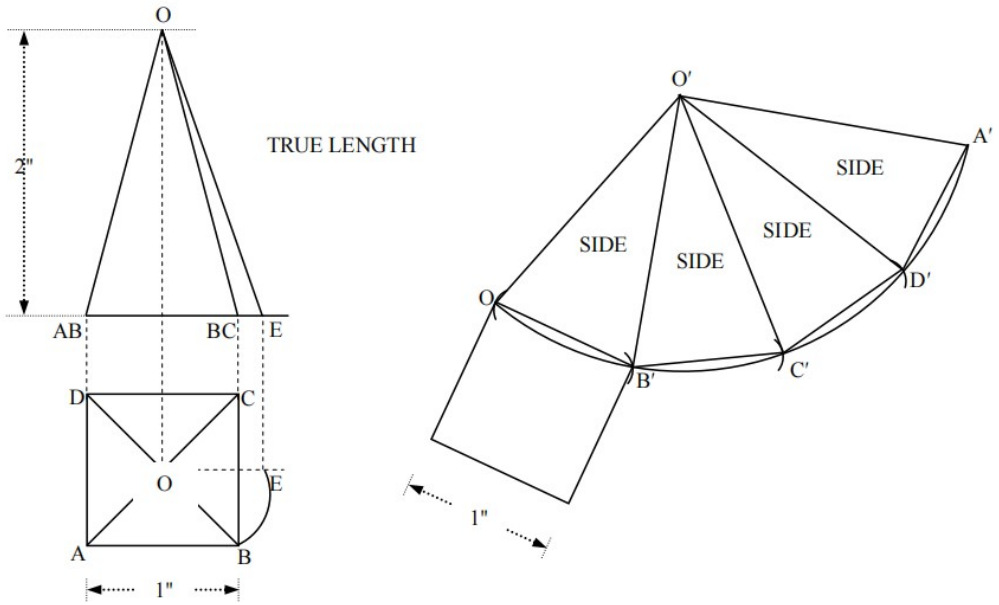


- **Develop the surfaces of a pyramid**



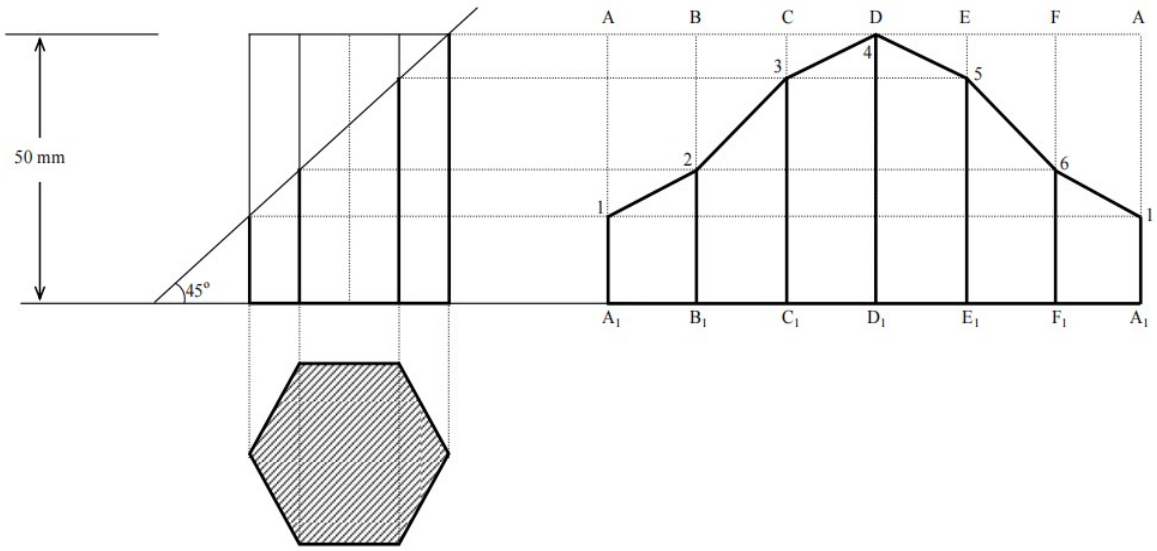


Draw the development of a square pyramid from its plan and front elevation which stands vertically on its base on H.P with one edge of the base parallel to V.P.



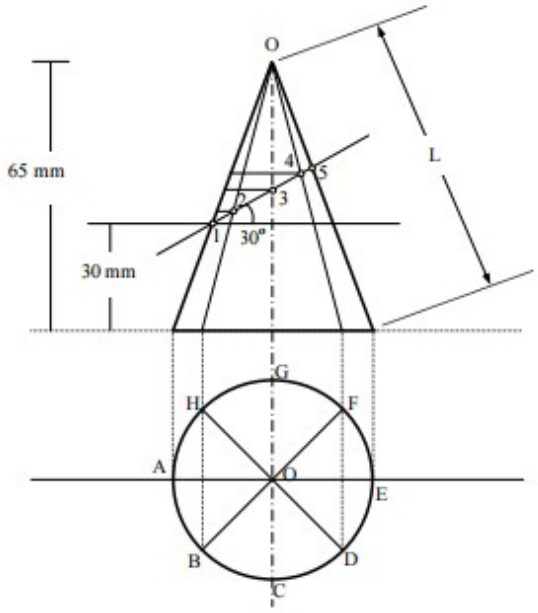
Problem:

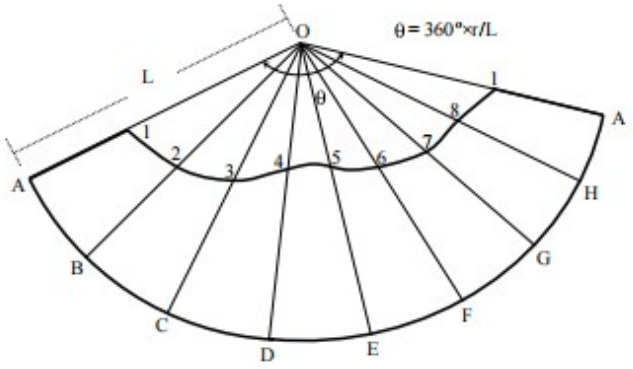
A hexagonal prism, edge of base 20 mm and axis 50 mm long, rests with its base on H.P such that one of its rectangular faces is parallel to V.P. It is cut by a plane perpendicular to V.P, inclined at 45° to H.P and passing through the right corner of the top face of the prism. Draw the sectional top view and develop the lateral surface of the truncated prism.



Problem:

A cone of base 50 mm diameter and height 65 mm rests with its base on H.P. A section plane perpendicular to V.P and inclined at 30° to H.P bisects the axis of the cone. Draw the development of the lateral surface of the truncated cone.





Engineering Graphics Ex-8

PROJECTION OF SURFACES

Q.1. Draw the development of the lateral surface of a pyramid, side of base 25mm and height 50mm, resting with it's base H.P. and an edge of the base parallel to V.P.

Q.2. A cylinder of diameter of base 40mm and axis 55mm long is resting on its base on H.P. it is cut by a section plane perpendicular to V.P. and inclined at 45° to H.P. The section plane is passing through the top end of an extreme generator of the cylinder. Draw the development of the lateral surface of the truncated cylinder.

Q.3. A hexagonal prism, edge of base 20mm and axis 50mm long, rests on its base on H.P., such that one of its rectangular face is parallel to V.P.it is cut by a section plane perpendicular to V.P. inclined at 45° to H.P. and passing through the right side corner of the top of the prism .Develop the lateral surface of the truncated prism.

Q.4. A cone of base 40mm diameter and slant height 60mm rests with its base on V.P. A section plane perpendicular to H.P. and inclined at 30° to V.P. bisects the axis of the cone .Draw the development of the e lateral surface of the truncated cone.

EXPLODE :

- It is used to convert the single object to multiple entities.
- Command : x ↲
- Modify menu → explode →select the single object.

PLOT SET-UP

- Plot Set- up→ command
- CTRL+P →Select printer/plotter Option
- Paper size → What to plot(Display ,Extents , Limits ,window),
- choose any option → click the first point corner to specify opposite corner
- check center the plot
- preview → press space bottom Number of copies → ok