SYLLABUS

MALLAREDDY COLLEGE OF ENGINEERING AND TECHNOLOGY

I Year B. Tech MECH-I Sem

ENGINEERING GRAPHICS

Course Objectives:
1. Learn to sketch and take field dimensions.
2. Learn to take data and transform it into graphic drawings.
3. Learn basic engineering drawing formats

UNIT – I

Introduction To Engineering Drawing: Principles of Engineering Drawing/Graphics – Various Drawing Instruments – Conventions in Drawing- Dimensioning – Lettering practice – BIS Conventions.

a) Polygons – Construction of regular polygons (General Method only)
b) Conic Sections (General Method only- Eccentricity Method)
c) Cycloid, Epicycloid and Hypocycloid
d) Scales-Plain, Diagonal and Vernier

UNIT – II

Orthographic Projection in First Angle only: Principles of Orthographic Projections – Conventions – First and Third Angle projections (Introduction).

Projections of Points. Points in all four quadrants.

Projections of Lines – Parallel and inclined to both planes.

UNIT – III

Projections of Planes: Projection of regular planes, Plane inclined to both reference planes (No conditional problems).

Projections of Solids: Projections of regular solids prism and pyramid inclined to both planes (No conditional problems).

UNIT – IV
Isometric Projections: Principles of Isometric Projection – Isometric Scale – Isometric Views– Conventions – Plane Figures, Simple and Compound Solids.

UNIT – V

Transformation of Projections: Conversion of Isometric Views to Orthographic Views. Conversion of orthographic views to isometric views – simple objects

Basic Principles of ACAD – Demo Only.

Course Outcomes:

1. Student's ability to convert sketches to engineered drawings will increase.
2. Students will be able to draw orthographic projections and sections.
3. Student's ability to perform basic sketching techniques will improve.

TEXT BOOKS
1. Engineering Drawing, Special Edition-MRCET, McGrahill Publishers, 2017.

SYLLABUS

2. Engineering Drawing, N.D. Bhatt
3. Engineering Drawing by K.Venu Gopal& V.Prabu Raja New Age Publications.

REFERENCES

1. Engineering drawing – P.J. Shah .S.Chand Publishers.
2. Engineering Drawing- Johle/Tata Macgraw Hill Book Publishers.

UNIT – 1

INTRODUCTION TO ENGINEERING DRAWING

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

Drawing Instruments and aids:

The Instruments and other aids used in drafting work are listed below:
- Drawing board
- Set squares
- French curves
- Templates
- Mini drafter
- Instrument box
- Protractor
- Set of scales
- Drawing sheets
- Pencils

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. Nowadays mini-drafters 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.
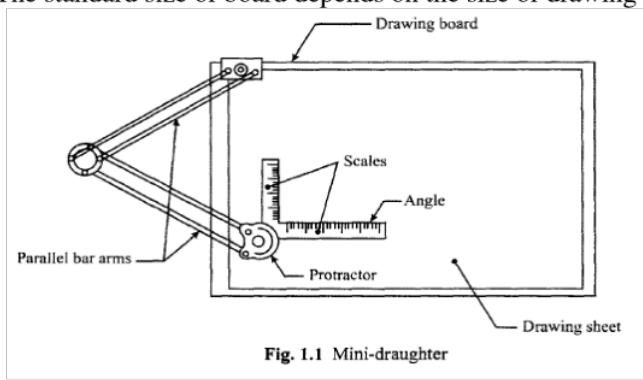
Fig. 1.1 Mini-draughter

Mini-Drafter:

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

Instrument Box

Instrument box contains 1. Compasses, 2. Dividers and 3. Inking pens.
What is important is the position of the pencil lead with respect to the tip of the compass. It should be at least 1 mm above as shown in the fig. because the tip goes into the board for grip by 1 mm.


(a) Sharpening and position of compass lead

(b) Position of the lead leg to draw larger circles
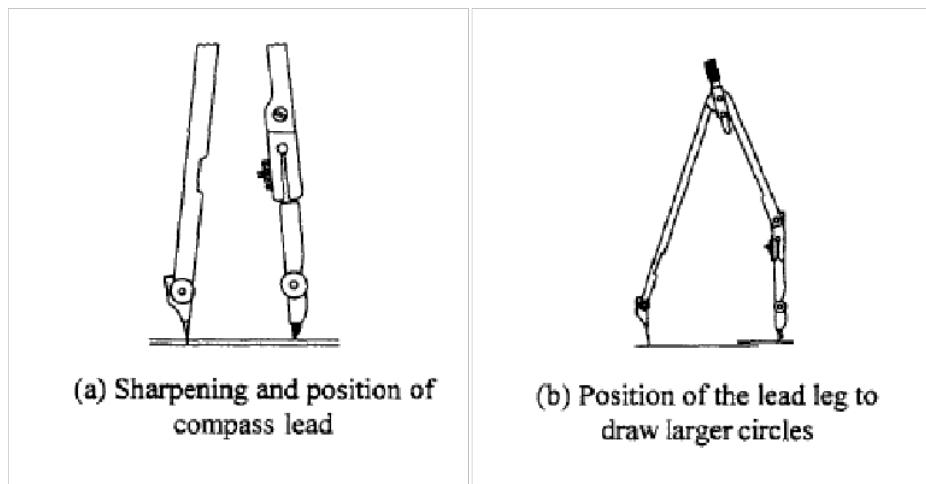
Figure.1.2

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.

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

Drawing Sheet:

The standard drawing sheet sizes are arrived at on the basic Principal of x: y = 1: 2^ (1/2) and xy = 1 where x and y are the sides of the sheet. For example AO, having a surface area of 1 Sq.m; x = 841 mm and y = 1189 mm. The successive sizes are obtained by either by halving along the length or doubling the width, the area being in the ratio 1: 2. Designation of sizes is given in the fig. For class work use of A2 size drawing sheet is preferred.

| Designation	Dimension, mm Trimmed size
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297
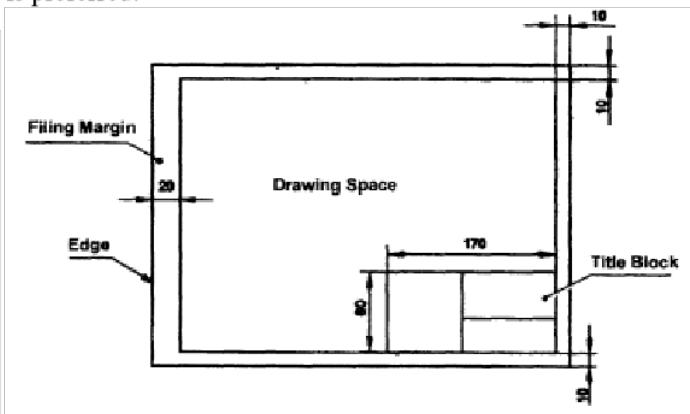
Table.1.1   Figure .1.3
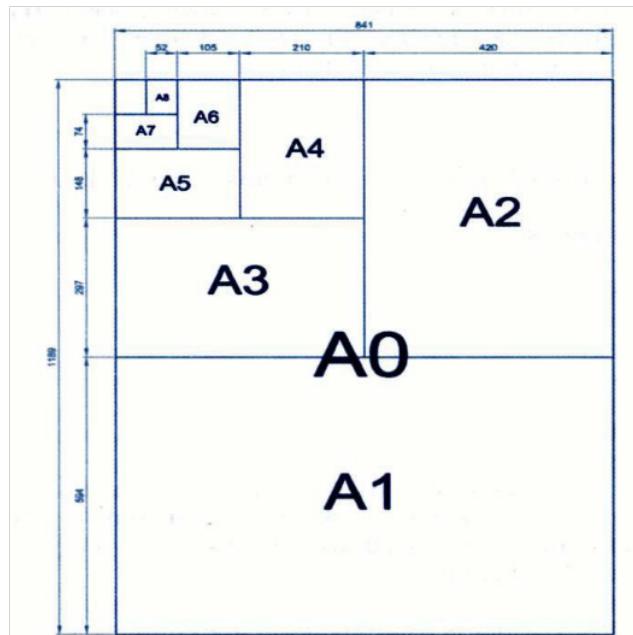
Figure.1.4

Title Block:

The title block should lie within the drawing space at the bottom right hand corner of the sheet. The title block can have a maximum length of 170 mm and width of 65mm providing the following information.

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

Lines:

Just as in English textbook the correct words are used for making correct sentences; in Engineering Graphics, the details of various objects are drawn by different types of lines. Each line has a definite meaning and sense to convey.

- **Visible Outlines, Visible Edges:** (Continuous wide lines) the lines drawn to represent the visible outlines/ visible edges / surface boundary lines of objects should be outstanding in appearance.
- **Dimension Lines (Continuous narrow Lines):** Dimension Lines are drawn to mark dimension.
- **Extension Lines (Continuous narrow Lines):** There are extended slightly beyond the respective dimension lines.
- **Construction Lines (Continuous narrow Lines):** These are drawn for constructing drawings and should not be erased after completion of the drawing.
- **Hatching / Section Lines (Continuous Narrow Lines):** These are drawn for the sectioned portion of an object. These are drawn inclined at an angle of 45° to the axis or to the main outline of the section.

- **Guide Lines (Continuous Narrow Lines):** These are drawn for lettering and should not be erased after lettering.
- **Break Lines (Continuous Narrow Freehand Lines):** Wavy continuous narrow line drawn freehand is used to represent break of an object.
- **Break Lines (Continuous Narrow Lines With Zigzags):** Straight continuous narrow line with zigzags is used to represent break of an object.
- **Dashed Narrow Lines (Dashed Narrow Lines):** Hidden edges / Hidden outlines of objects are shown by dashed lines of short dashes of equal lengths of about 3 mm, spaced at equal distances of about 1 mm. the points of intersection of these lines with the outlines / another hidden line should be clearly shown.
- **Center Lines (Long-Dashed Dotted Narrow Lines):** These are draWn at the center of the drawings symmetrical about an axis or both the axes. These are extended by a short distance beyond the outline of the drawing.
- **Cutting Plane Lines:** Cutting Plane Line is drawn to show the location of a cutting plane. It is long-dashed dotted narrow line, made wide at the ends, bends and change of direction. The direction of viewing is shown by means of arrows resting on the cutting plane line.
- **Border Lines:** Border Lines are continuous wide lines of minimum thickness 0.7 mm.
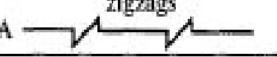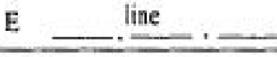
No.	Line description and Representation	Applications
01.1	Continuous narrow line B	Dimension lines, Extension lines
		Leader lines, Reference lines
		Short centre lines
		Projection lines
		Hatching
		Construction lines, Guide lines
		Outlines of revolved sections
		Imaginary lines of intersection
01.1	Continuous narrow freehand line C	Preferably manually represented termination of partial or interrupted views, cuts and sections, if the limit is not a line of symmetry or a center line[4].
01.1	Continuous narrow line with zigzags A	Preferably mechanically represented termination of partial or interrupted views, cuts and sections, if the limit is not a line of symmetry or a center line[4].
01.2	Continuous wide line	Visible edges, visible outlines
		Main representations in diagrams, maps, flow charts
02.1	Dashed narrow line D	Hidden edges
		Hidden outlines
04.1	Long-dashed dotted narrow line E	Center lines / Axes, Lines of symmetry
		Cutting planes (Line 04.2 at ends and changes of direction)
04.2	Long-dashed dotted wide line F	Cutting planes at the ends and changes of direction outlines of visible parts situated in front of cutting plane

Table.1.2

## CONVENTIONAL REPRESENTATION OF MATERIALS
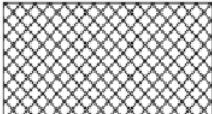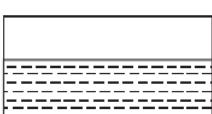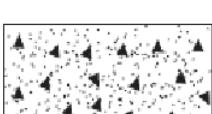
| Type	Convention	Material
Metals		Steel, Cast Iron, Copper and its Alloys, Aluminium and its Alloys, etc.
		Lead, Zinc, Tin, White-metal, etc.
Glass		Glass
Packing and Insulating material		Porcelain, Stoneware, Marble, Slate, etc.
		Asbestos, Fibre, Felt, Synthetic resin products, Paper, Cork, Linoleum, Rubber, Leather, Wax, Insulating and Filling materials, etc.
Liquids		Water, Oil, Petrol, Kerosene, etc.
Wood		Wood, Plywood, etc.
Concrete		A mixture of Cement, Sand and Gravel

Table.1.3

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

Procedure for Lettering:

1. Thin horizontal guide lines are drawn first at a distance ' h' apart.
2. Lettering Technique: Horizontal lines of the letters are drawn from left to right. Vertical, Inclined and curved lines are drawn from top to bottom.
3. After lettering has been completed, the guidelines are not erased.

Specifications	Value	Size						
Capital Letter Height	h	2.5	3.5	5	7	10	14	20
Lowercase Letter Height	$a = (5/7)h$	–	2.5	3.5	5	7	10	14
Thickness of Lines	$b = (1/14)h$	0.18	0.25	0.35	0.5	0.7	1	1.4
Spacing between Characters	$c = (1/7)h$	0.35	0.5	0.7	1	1.4	2	2.8
Min.Spacing between words	$d = (3/7)h$	1.05	1.5	2.1	3	4.2	6	8.4
Min. Spacing between Base Lines	$e = (10/7)h$	3.5	5	7	10	14	20	28

Table.1.4

Recommended Size (height h) of Letters / Numerals	
Main Title	5 mm, 7 mm, 10 mm
Sub-Titles	3.5 mm, 5 mm
Dimensions, Notes, etc.	2.5 mm, 3.5 mm, 5 mm

Table.1.5

Dimensioning:

Drawing of a component, in addition to providing complete shape description, must also furnish Information regarding the size description. These are provided through the distances between the Surfaces, location of holes, nature of surface finish, type of material, etc. The expression of these Features on a drawing, using lines, symbols, figures and notes is called dimensioning.
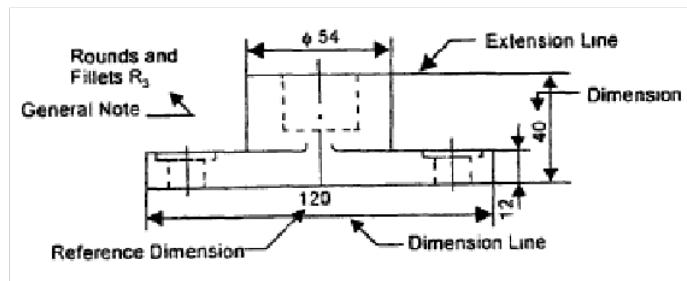
Figure.1.5

Methods of Indicating Dimensions:

The dimensions are indicated on the drawings according to one of the following two methods.

Method - 1 (Aligned method):

Dimensions should be placed parallel to and above their dimension lines and preferably at the middle, and clear of the line. Dimensions may be written so that they can be read from the bottom or from the right side of the drawing. Dimensions on oblique dimension lines should be oriented as shown in Fig.2.26a and except where unavoidable, they shall not be placed in the 30° zone. Angular dimensions are oriented.
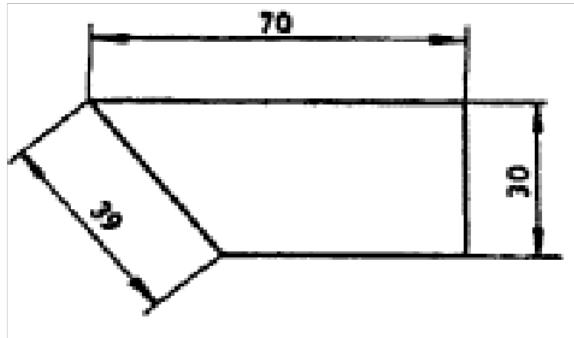

Figure.1.6(a)
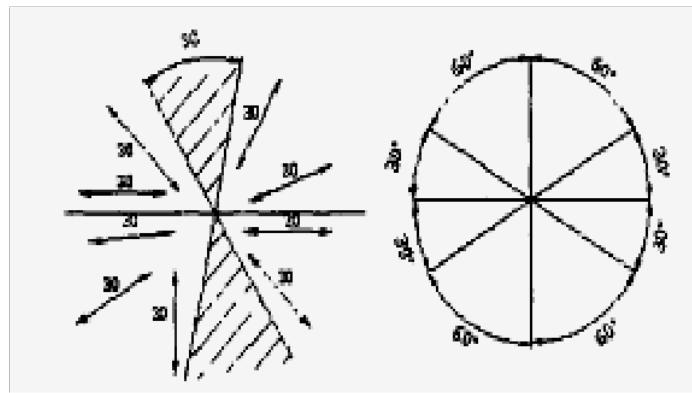
Figure.1.6 (b)

Method - 2 (Uni-directional):

Dimensions should be indicated so that they can be read from the bottom of the drawing only. Non-horizontal dimension lines are interrupted, preferably in the middle for insertion of the dimension. Note: Horizontal dimensional lines are not broken to place the dimension in both cases.
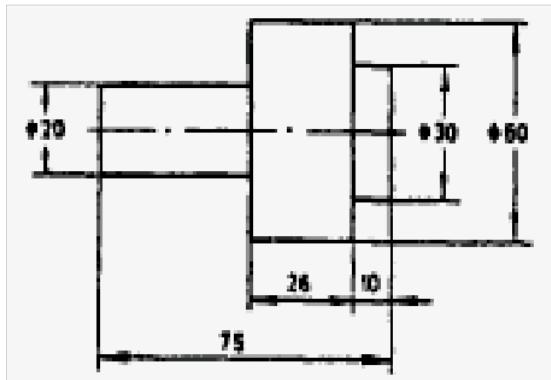

Figure.1.7

GEOMETRICAL CONSTRUCTIONS

Introduction:

Engineering drawing consists of a number of geometrical constructions. A few methods are illustrated here without mathematical proofs.

1. a) To divide a straight line into a given number of equal parts say 5.
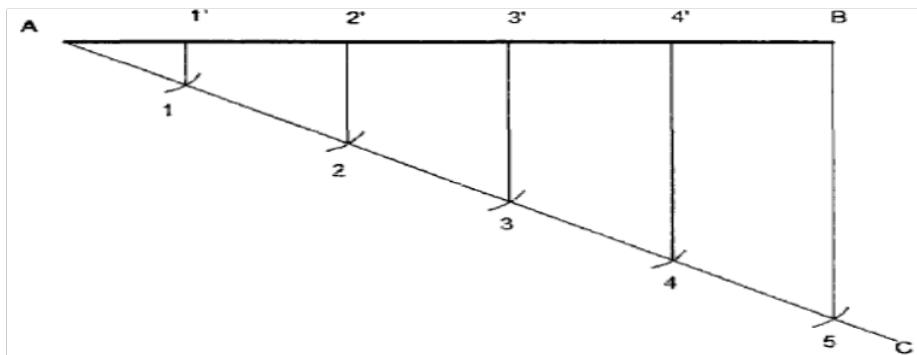
Figure.1.8

Construction:

1. Draw AC at any angle θ to AB
2. Construct the required number of equal parts of convenient length on AC like 1,2,3.
3. Join the last point 5 to B
4. Through 4, 3, 2, 1 draw lines parallel to 5B to intersect AB at 4',3',2' and 1'.

b) To bisect a given angle.
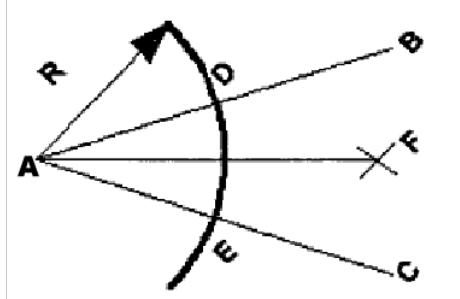
Figure.1.9

Construction:

1. Draw a line AB and AC making the given angle.
2. With centre A and any convenient radius R draw an arc intersecting the sides at D and E.
3. With centre's D and E and radius larger than half the chord length DE, draw arcs intersecting at F
4. Join AF, <BAF = <FAC.

2. To inscribe a regular polygon of any number of sides in a given circle.

Construction:

1. Draw the given circle with AB as diameter.
2. Divide the diameter AB into N equal parts say 5.
3. With AB as radius and A & B as centers, draw arcs intersecting each other at C.
4. Join C-P and extend to intersect the circle at D.

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5. Join A-D which is the length of the side of the required polygon.
6. Set the compass to the length AD and starting from D mark off on the circumference of the circles, obtaining the points E,F, etc. The figure obtained by joining the points A,D,E etc., is the required polygon.
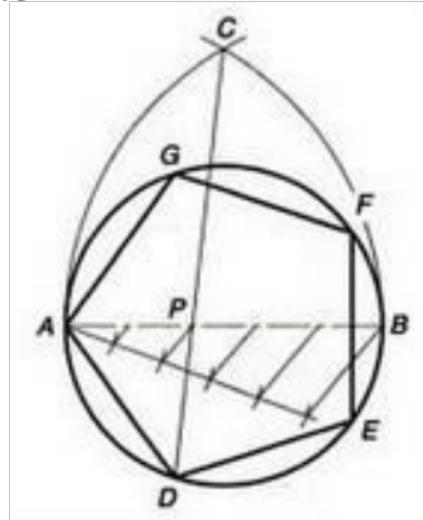
Figure.1.10

3. *To inscribe a hexagon in a given circle.*
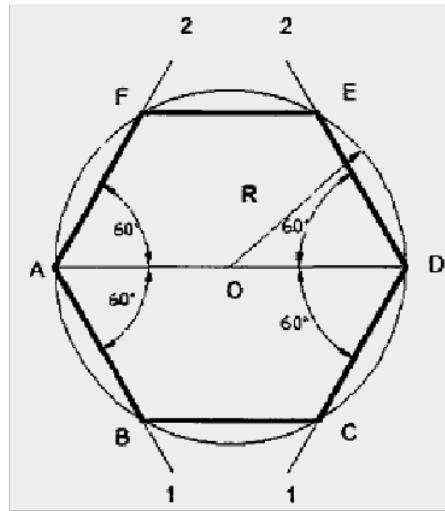
Figure.1.11

Construction:

1. With centre O and radius R draw the given circle.
2. Draw any diameter AD to the circle.
3. Using 30° - 60° set-square and through the point A draw lines A1, A2 at an angle 60° with AD, intersecting the circle at B and F respectively.
4. Using 30°-60° set-square and through the point D draw lines Dl, D2 at an angle 60° with DA, intersecting the circle at C and E respectively.
5. By joining A,B,C,D,E,F and A,S the required hexagon is obtained.

4. *To construct a regular polygon (say a pentagon) given the length of the side.*

Construction:

1. Draw a line AB equal to the side and extend to P such that AB = BP

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2. Draw a semicircle on AP and divide it into 5 equal parts by trial and error.
3. Join B to second division Irrespective of the number of sides of the polygon B is always joined to the second division.
4. Draw the perpendicular bisectors of AB and B2 to intersect at O.
5. Draw a circle with O as centre and OB as radius.
6. With AB as radius intersect the circle successively at D and E. Then join CD, DE and EA.
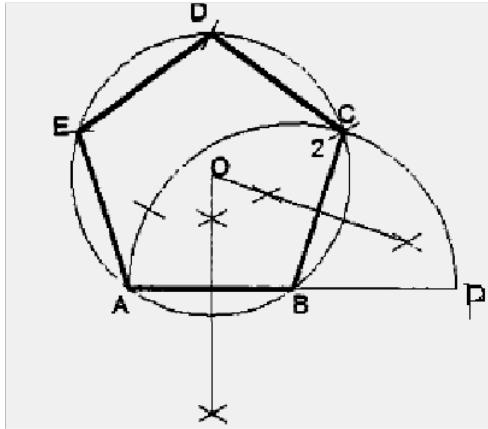
Figure.1.12

5. *To construct a regular polygon (say a hexagon) given the side AB .*

Construction:

1. Draw a line AB equal to the side and extend to P such that AB = BP
2. Draw a semicircle on AP and divide it into 6 equal parts by trial and error.
3. Join B to second division
4. Join B- 3, B-4, B-5 and produce them.
5. With 2 as centre and radius AB intersect the line B, 3 produced at D. Similarly get the point E and F.
6. Join 2- D, D-E, E-F and F-A to get the required hexagon.
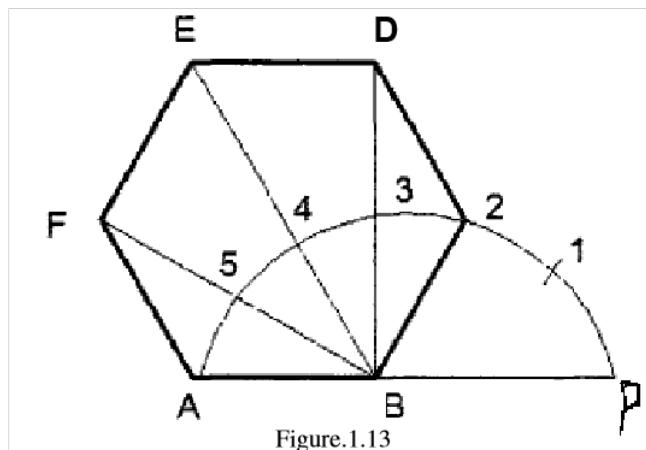
Figure.1.13

7. *To construct a regular figure of given side length and of N sides on a straight line.*

Construction:

1. Draw the given straight line AB.

---

2. At B erect a perpendicular BC equal in length to AB.
3. Join AC and where it cuts the perpendicular bisector of AB, number the point 4.
4. Complete the square ABCD of which AC is the diagonal.
5. With radius AB and centre B describe arc AC as shown.
6. Where this arc cuts the vertical centre line numbers the point 6.
7. This is the centre of a circle inside which a hexagon of side AB can now be drawn.
8. Bisect the distance 4-6 on the vertical centre line.
9. Mark this bisection 5. This is the centre in which a regular pentagon of side AB can now be drawn.
10. On the vertical centre line step off from point 6 a distance equal in length to the distance 5-6. this is the centre of a circle in which a regular heptagon of side AB can now be drawn.
11. If further distances 5-6 are now stepped off along the vertical centre line and are numbered consecutively, each will be the centre of a circle in which a regular polygon can be inscribed with side of length AB and with a number of sides denoted by the number against the centre.
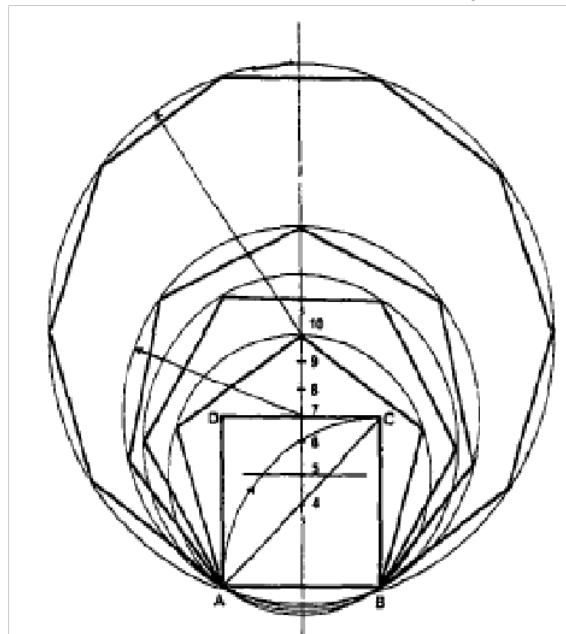
Figure.1.14

CONIC SECTIONS

Cone is formed when a right angled triangle with an apex and angle θ is rotated about its altitude as the axis. The length or height of the cone is equal to the altitude of the triangle and the radius of the base of the cone is equal to the base of the triangle. The apex angle of the cone is 2θ. When a cone is cut by a plane, the curve formed along the section is known as a conic.

a) CIRCLE:

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

b) ELLIPSE:

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

c) PARABOLA:

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

d) HYPERBOLA:

If the angle α is less than θ (section plane D-D), the curve at the section is hyperbola. The curve of intersection is hyperbola, even if $\alpha = \theta$, provided the section plane is not passing through the apex of the cone. However if the section plane passes through the apex, the section produced is an isosceles triangle.
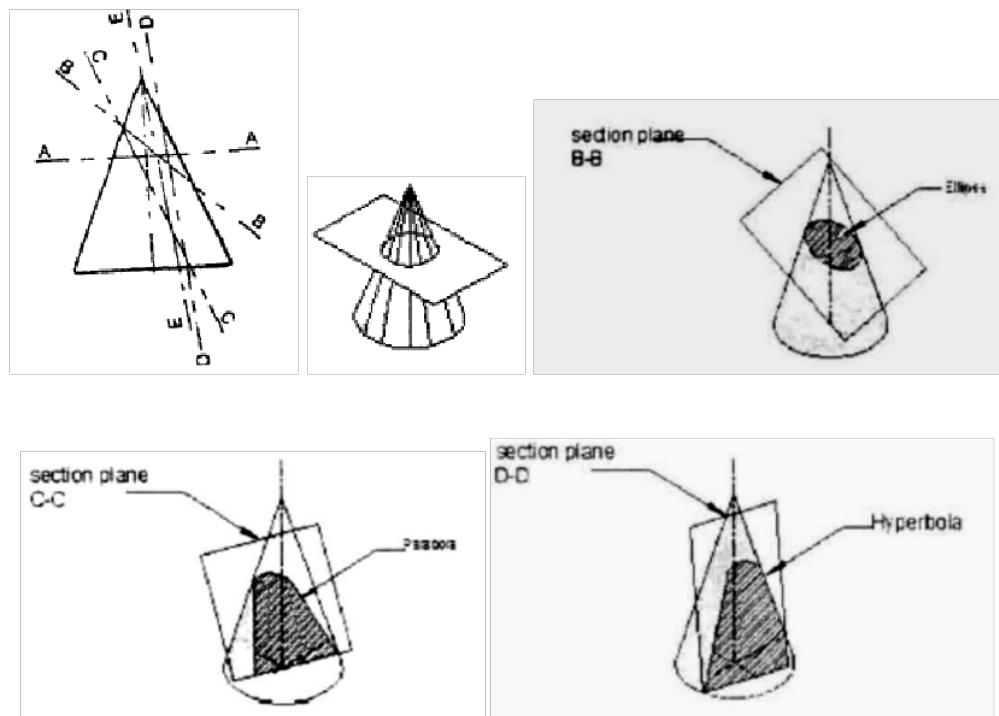

Figure.1.15

Eccentricity(e) :

        a. If e=1, it is parabola
        b. If e>1, it is hyperbola
        c. If e<1, it is an ellipse

Where eccentricity e is the ratio of distance of the point from the focus to the distance of the point from the directrix.

PARABOLA:

In physical world, parabola are found in the main cables on simple suspension bridge, as parabolic reflectors in satellite dish antennas, vertical curves in roads, trajectory of a body, automobile head light, parabolic receivers.


A projectile often moves horizontally as it moves upward and/or downward.
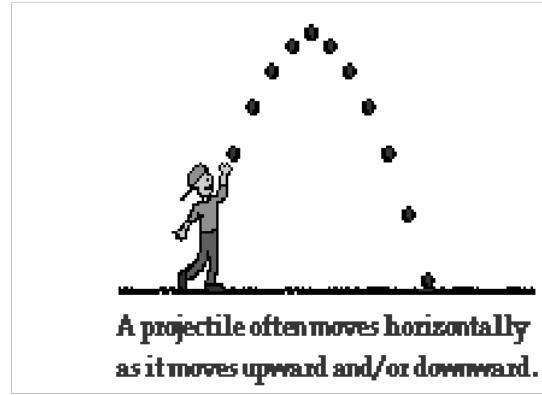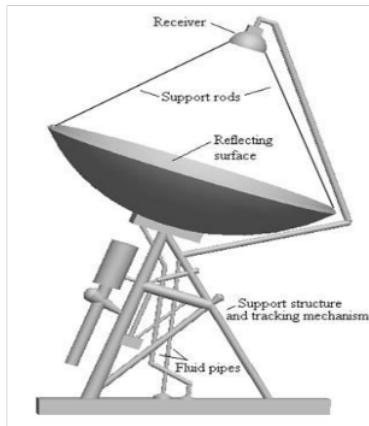
Figure.1.16

- *To draw a parabola with the distance of the focus from the directrix at 50mm (Eccentricity method)*

Construction:

1. Draw the axis AB and the directrix CD at right angles to it:
2. Mark the focus F on the axis at 50mm.
3. Locate the vertex V on AB such that AV = VF
4. Draw a line VE perpendicular to AB such that VE = VF
5. Join A, E and extend. Now, VE/VA = VF/VA = 1, the eccentricity.
6. Locate number of points 1, 2, 3, etc., to the right of V on the axis, which need not be equidistant.
7. Through the points 1, 2, 3, etc., draw lines perpendicular to the axis and to meet the line AE extended at 1',2',3' etc.
8. With centre F and radius 1-1', draw arcs intersecting the line through 1 at P1 and P`1
9. Similarly, locate the points P2, P`2, P3, P`3 etc., on either side of the axis. Join the points by smooth curve, forming the required parabola.
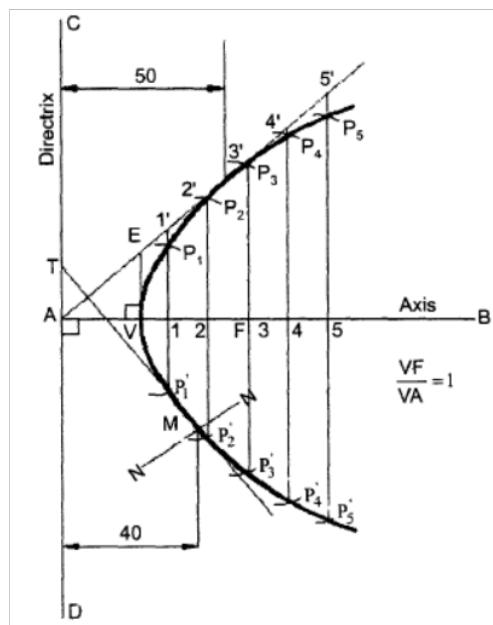
Figure.1.17

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

To draw a tangent and normal to the parabola. locate the point M which is at 40 mm from the directrix. Then join M to F and draw a line through F, perpendicular to MF to meet the directrix at T. The line joining T and M and extended is the tangent and a line NN, through M and perpendicular to TM is the normal to the curve.

ELLIPSE:

Ellipses are mostly found as harmonic oscillators, phase visualization, elliptical gears, ellipse wings.
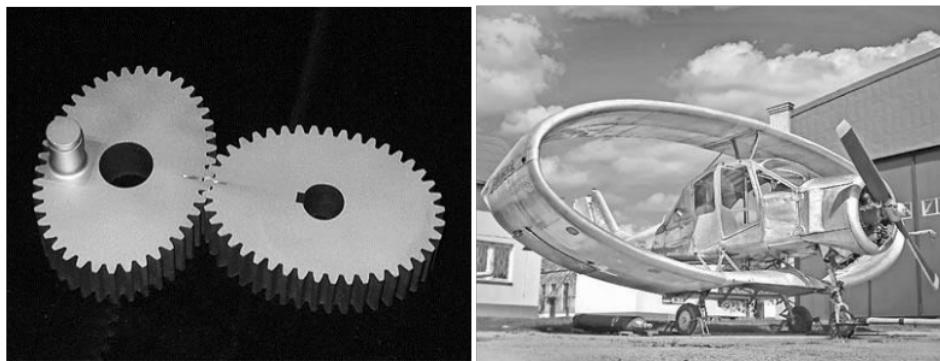
Figure.1.18

- *To draw an ellipse with the distance of the focus from the directrix at 50mm and eccentricity = 2/3 (Eccentricity method)*

Construction:

1. Draw any vertical line CD as directrix.
2. At any point A in it, draw the axis.
3. Mark a focus F on the axis such that AF1=50mm.
4. Divide AF1 in to 5 equal divisions.
5. Mark the vertex V on the third division-point from A.
6. Thus eccentricity e= VF1/VA = 2/3.
7. A scale may now be constructed on the axis which will directly give the distances in the required ratio.
8. At V, draw a perpendicular VE = VF1. Draw a line joining A and E.
9. Mark any point 1 on the axis and through it draw a perpendicular to meet AE produced at 1'.
10. With centre F and radius equal to 1-1', draw arcs to intersect a perpendicular through 1 at points P1 and P'1.
11. Similarly mark points 2, 3 etc. on the axis and obtain points P2 and P'2, P3 and P'3, etc.
12. Draw the ellipse through these points, it is a closed curve two foci and two directrices.
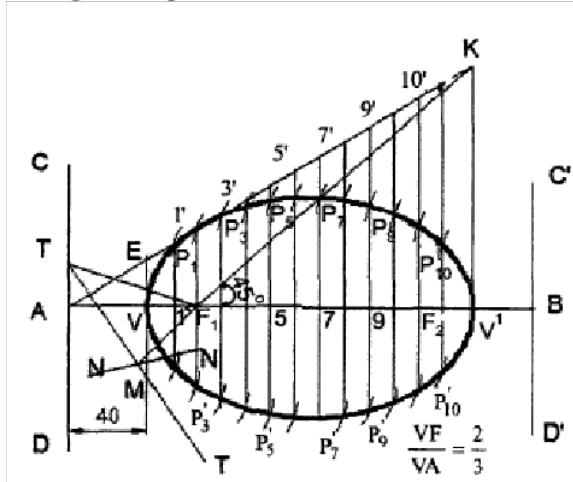
Figure.1.19

HYPERBOLA

Lampshades, gear transmission, cooling towers of nuclear reactors are some of the applications of Hyperbola.

Figure.1.20

- *To draw a hyperbola with the distance of the focus from the directrix at 50mm and e=3/2 (Eccentricity method)*
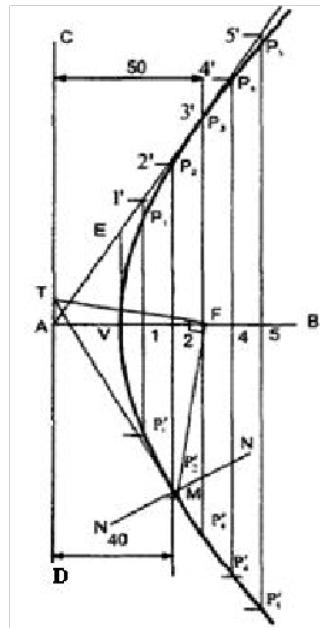
Figure.1.21

Construction:

1. Draw the directrix CD and the axis AB.
2. Mark the focus F on AB and 65mm from A.
3. Divide AF into 5 equal divisions and mark V the vertex, on the second division from A.
4. Draw a line VE perpendicular to AB such that VE=VF. Join A and E.
5. Mark any point 1 on the axis and through it, draw a perpendicular to meet AE produced at 1'.
6. With centre F and radius equal to 1-1', draw arcs intersecting the perpendicular through 1 at P1 and P'1.
7. Similarly mark a number of points 2, 3 etc and obtain points P2 and P'2, etc.

SPECIAL CURVES

CYCLOIDAL CURVES:

Cycloidal curves are generated by a fixed point in the circumference of a circle when it rolls without slipping along a fixed straight line or circular path. The rolling circle is called the generating circle, the fixed straight line, the directing line and the fixed circle, the directing circle.

In physical world, cycloidal curves are used as cycloidal gears, epicyclic train dynamometer, epicyclic gear train, hypocycloid engine.

CYCLOID:

A cycloid is a curve generated by a fixed point on the circumference of a circle, when it rolls without slipping along a straight line.

- *To draw a cycloid, given the radius R of the generating circle.*

Construction:

1. With centre O and radius R, draw the given generating circle.
2. Assuming point P to be the initial position of the generating point, draw a line PA, tangential And equal to the circumference of the circle.
3. Divide the line PA and the circle into the same number of equal parts and number the points.
4. Draw the line OB, parallel and equal to PA. OB is the locus of the centre of the generating Circle.
5. Errect perpendiculars at 1', 2', 3', etc., meeting OB at Q1, Q2,Q3 etc.
6. Through the points 1, 2, 3 etc., draw lines parallel to PA.
7. With centre O, and radius R, draw an arc intersecting the line through 1 at P1, P1 is the position of the generating point, when the centre of the generating circle moves to Q1.
8. Similarly locate the points P2, P3 etc.
9. A smooth curve passing through the points P, P1, P2, P3 etc., is the required cycloid.
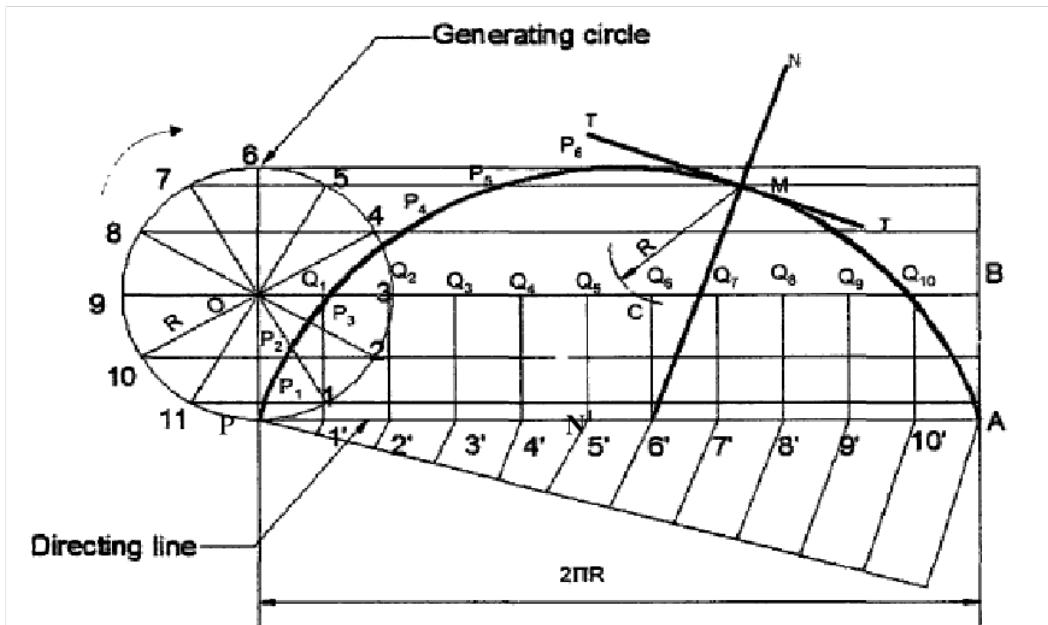
Figure.1.22

- *To draw a normal and tangent to a cycloid*

10. Mark a point M on the cycloid at a given distance from the directing line.
11. With M as a centre and the radius R, cut the centre line at point C.
12. Through point C, draw a line perpendicular to PA, Which meets PA at Point N^l.
13. Join N^lM and extend it to N. The line NN^l is the required normal.
14. Through Point M, draw a line TT^l Perpendicular to NN^l. The line TT^l is the required tangent.

EPICYCLOID:

An epi-cycloid is a curve traced by a point on the circumference of a generating circle, when it rolls without slipping on another circle (directing circle) outside it.

- *To draw an epi-cyloid, given the radius 'r' of the generating circle and the radious 'R' of the directing circle.*

Construction:

1. With centre O' and radius R, draw a part of the directing circle.
2. Draw the generating circle, by locating the centre O of it, on any radial line O' P extended such that OP = r .
3. Assuming P to be the generating point, locate the point, A on the directing circle such that the arc length PA is equal to the circumference of the generating circle. The angle subtended by the arc PA at O' is given by $\theta = angle\ PO'A = \frac{r}{R} * 360^0$
4. With centre O' and radius O'O, draw an arc intersecting the line O'A produced at B. The arc OB is the locus of the centre of the generating circle.
5. Divide the arc PA and the generating circle into the same number of equal parts and number the points.
6. Join O'-1', O'-2', etc., and extend to meet the arc OB at O1,O2 etc.
7. Through the points 1, 2, 3 etc., draw circular arcs with O' as centre.
8. With centre O1 and radius r, draw an arc intersecting the arc through 1 at P1.
9. Similarly, locate the points P2, P3 etc.
10. A smooth curve through the points P1, P2, P3 etc., is the required epi-cycloid.
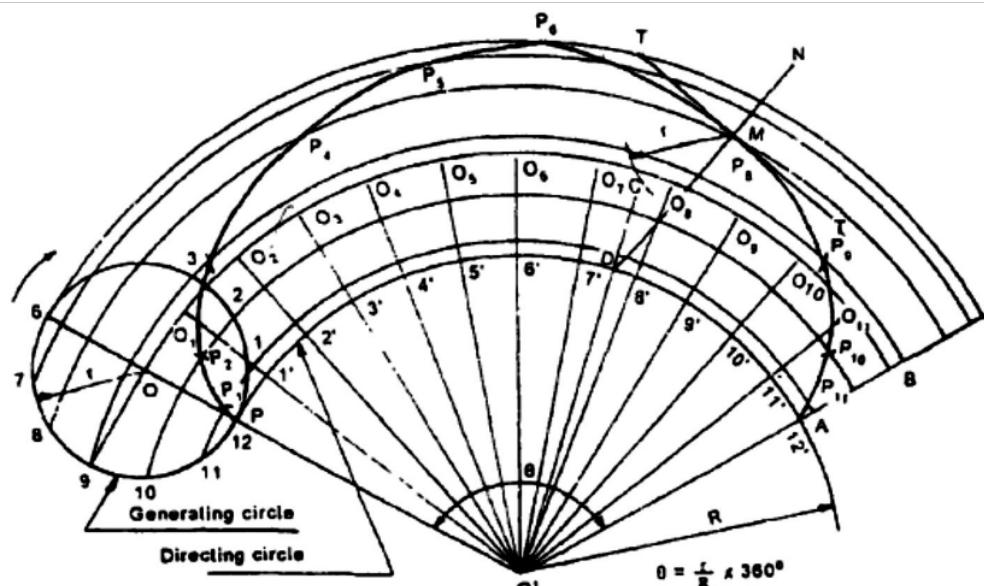
Figure.1.23

- *To draw a normal and tangent to a Epicycloid.*

11. Mark a point M on the epicycloid at a given distance from the Point O'.
12. With M as the centre and radius r , cut the centre arc OB at point C.
13. Join O'C to meet the arc PA at point D.
14. Join DM and Produce it to N. The line DN is the required normal.
15. Through Point M, Draw a line TT^l Perpendicular to DN. The line TT^l is the required tangent.

HYPOCYCLOID:

If the generating circle rolls inside the directing circle, the curve traced by the point in called hypo-cycloid.

- *Draw a hypocycloid of a circle of 40 mm diameter which rolls inside another circle of 200 mm diameter for one revolution. Draw a tangent and normal at any point on it.*

Construction:

1. Taking any point O as centre and radius (R) 100 mm draw an arc PQ which subtends an angle $\theta = 72°$ at O. $\theta = angle\ PO'Q = \frac{r}{R} * 360^0$
2. Let P be the generating point. On OP mark PC = r = 20 mm, the radius of the rolling circle.
3. With C as centre and radius r (20 mm) draw the rolling circle. Divide the rolling circle into 12 equal parts as 1,2,3 etc., in clock wise direction, since the rolling circle is assumed to roll counter clock wise.
4. With O as centre, draw concentric arcs passing through 1, 2, 3 etc.
5. With O as centre and OC as radius draw an arc to represent the locus of centre.
6. Divide the arc PQ into same number of equal parts (12) as 1', 2', 3' etc.
7. Join O'1,O'2 etc., which intersect the locus of centre at C1C2C3 etc.
8. Taking centre C1 and radius r, draw an arc cutting the arc through 1 at P1 . Similarly obtain the other points and draw a smooth curve through them.

- *To draw a tangent and normal at a given point M:*

1. With M as centre and radius r = CP cut the locus of centre at the point N.
2. Join ON and extend it to intersect the base circle at S.
3. Join MS, the normal.
4. At M, draw a line perpendicular to MS to get the required tangent.
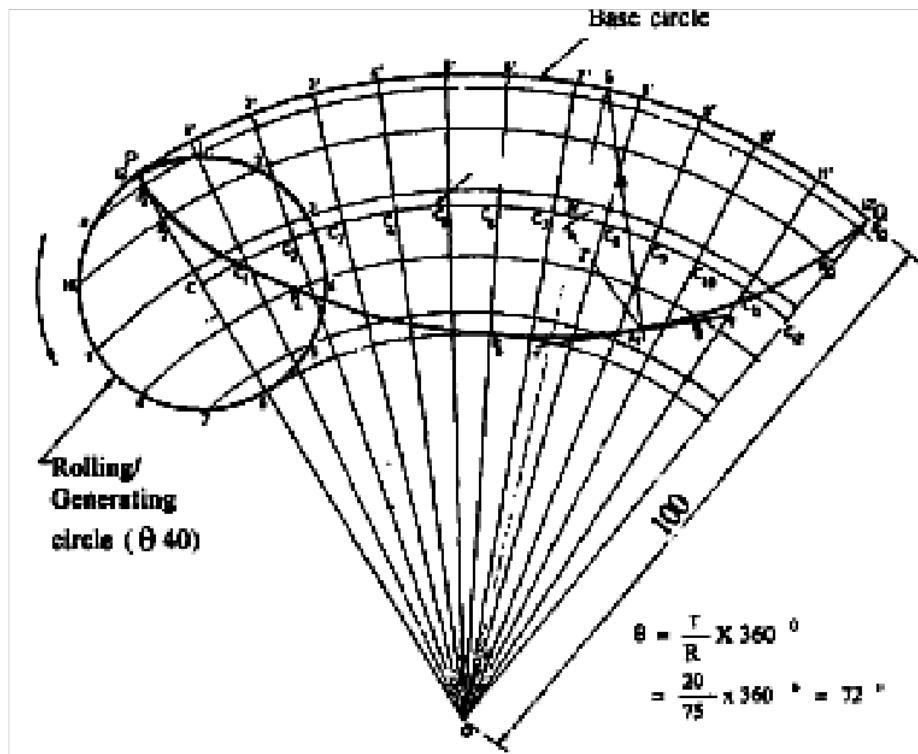
Figure.1.24

Example : Draw an epicycloid of rolling circle of diameter 40 mm which rolls outside another circle (base circle) of 150 mm diameter for one revolution. Draw a tangent and normal at any point on the curve.
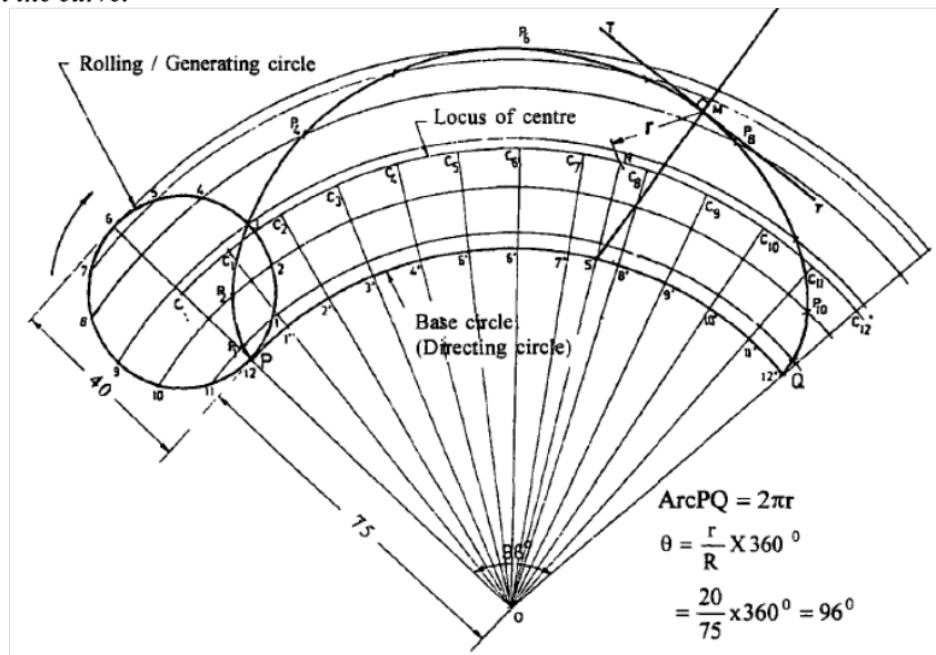

Figure.1.35

$$\theta = angle\ PO'Q = \frac{r}{R} * 360^0$$

SCALES

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

Representative Fraction:

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

$$RF = \frac{Dimension\ of\ Drawing}{Dimension\ of\ object\ (actual\ dimensions)} = \frac{Length\ of\ the\ object\ in\ the\ drawing}{actual\ length}$$

**For computing R.F, the numerator and denominator should be in same units

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 (bm)	= 1 kilometre (km)
1 hectare	= 10,000 m^2

Types of Scales:

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.

1. *Construct a scale of 1:40 to read metres and decimetres and long enough to measure 6 m. Mark on it a distance of 4.7 m.*
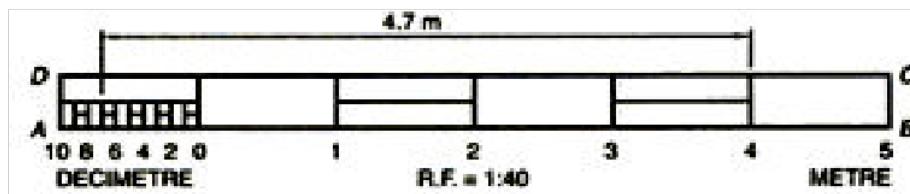
Figure.1.36

1. Given (a) R.F. = 1/40, (b) Maximum = 6 m and (c) Least count = 1 dm.
2. Calculate length of scale

$$L_s = R.F. \times maximum\ length = \frac{1}{40} \times 6 \times 100\ cm = 15\ cm$$

3. Draw a rectangle having length *AB* = 15 cm and width *AD* = 10 mm.
4. As the length of scale represents 6 m, divide it into 6 equal parts so that each part may represent 1 metre and mark the main units as shown.
5. Divide the first part 0*A* into 10 divisions, so that each division may represent 1 dm. Mark sub-units on the scale as shown.
6. Write the R.F. below the scale.
7. Mark a 4.7 m length on the scale, i.e., 4 metre on the right side of the zero mark and 7 decimetre on the left side of zero mark.

2. *The distance between two towns is 250 km and is represented by a line of length 50mm on a map. Construct a scale to read 600 km and indicate a distance of 530 km on it.*

Distance (Length) between two towns in the drawing = 50mm
Actual distance (length) = 250 km = 250*1000*1000 mm
**Therefore, R.F =50mm/250km**=50mm/250×1000×1000mm=$1/5×10^6$
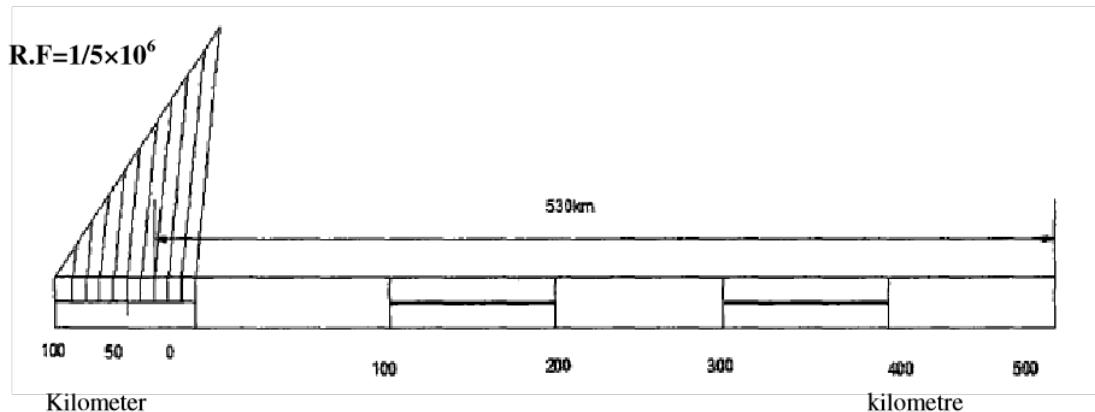
Figure.1.37

Diagonal Scales:

Diagonal scales are used to represent either three units of measurements such as metres,decimetres, centimetres or to read to the accuracy correct to two decimals.

Principle of Diagonal Scale:

The diagonal scales give us three successive dimensions that is a unit, a subunit and a subdivision of a subunit.
The principle of construction of a diagonal scale is as follows.
 • Let the XY in figure be a subunit.
 • From Y draw a perpendicular YZ to a suitable height.
 • Join XZ. Divide YZ in to 10 equal parts.
 • Draw parallel lines to XY from all these divisions and number them as shown.
 • From geometry we know that similar triangles have their like sides proportional.
 • Consider two similar triangles XYZ and 7' 7Z,
 • we have 7Z / YZ = 7'7 / XY (each part being one unit)
 • Means 7' 7 = 7 / 10. x X Y = 0.7 XY
Similarly
  1' – 1 = 0.1 XY
  2' – 2 = 0.2 XY
Thus, it is very clear that, the sides of small triangles, which are parallel to divided lines, become progressively shorter in length by 0.1 XY.

3. *The distance between Delhi and Agra is 200 km. In a railway map it is represented by a line 5 cm long. Find its R.F. Draw a diagonal scale to show single km. And maximum 600 km. Indicate on it following distances. 1) 222 km 2) 336 km 3) 459 km 4) 569 km*
RF = 5 cm / 200 km = 1 / 40, 00, 000
Length of scale = 1 / 40, 00, 000 X 600 X 10^5 = 15 cm

R.F. = 1 / 40,00,000
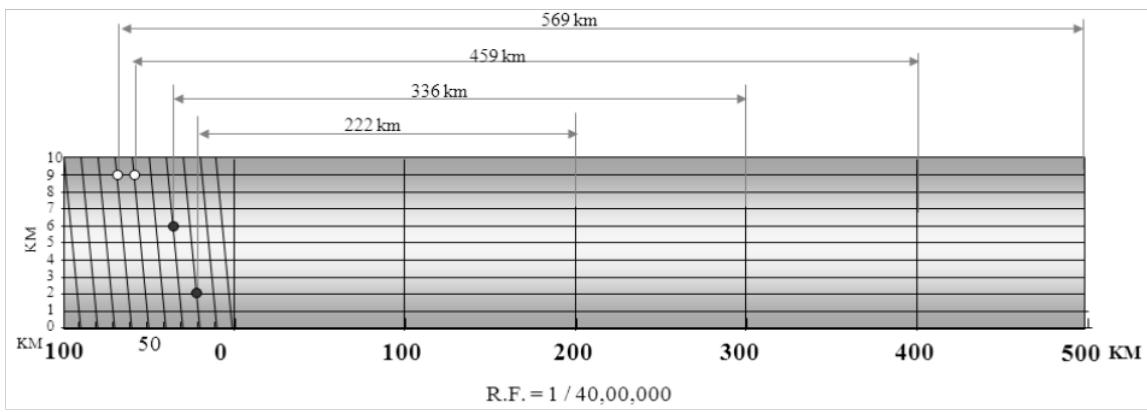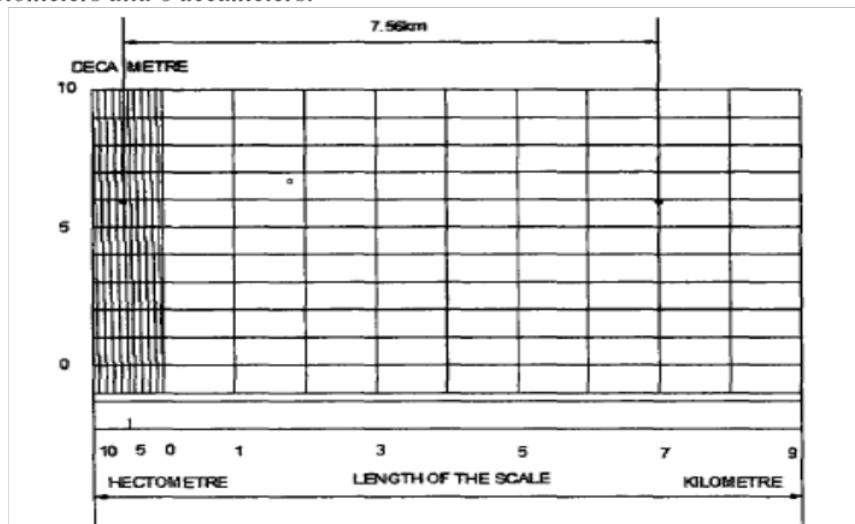
Figure.1.38

4. *An area of 144 sq cm on a map represents an area of 36 sq Km on the field. Find the RF of the scale of the map and draw a diagonal scale to show Km, hectometers and decameters and to measure up to 10 Km. Indicate on the scale a distance 7 Km, 5 hectometers and 6 decameters.*

R.F.= 12/6×1000×100

Fig.1.39

5. *Construct a diagonal scale 1/50, showing metres, decimetres and centimetres, to measure upto 5 metres. Mark a length 4. 75 m on it.*

R.F = 1/50
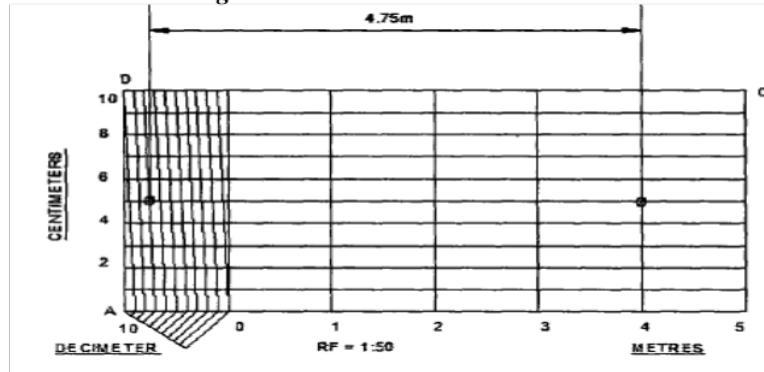
Figure.1.40

Vernier Scale:

The vernier scale is a short auxiliary scale constructed along the plain or main scale, which can read up to two decimal places.

- The smallest division on the main scale and vernier scale are 1 msd or 1 vsd respectively. Generally (n+ 1) or (n-l) divisions on the main scale is divided into n equal parts on the vernier scale.
- When 1 vsd < 1 it is called forward or direct vernier. The vernier divisions are numbered in the same direction as those on the main scale.
- When 1 vsd> 1 or (1 + 1/n), It is called backward or retrograde vernier. The vernier divisions are numbered in the opposite direction compared to those on the main scale.
- The least count (LC) is the smallest dimension correct to which a measurement can be made with a vernier.
- For forward vernier, L C = (1 msd - 1 vsd)
- For backward vernier, LC = (1 vsd - 1 msd)

6. *Construct a forward reading vernier scale to read distance correct to decameter on a map in which the actual distances are reduced in the ratio of 1: 40,000. The scale should be long enough to measure up to 6 km. Mark on the scale a length of 3.34 km and 0.59 km.*

Construction:

1. RF = 1140000; length of drawing = 40000 = 15 cm
2. 15 cm is divided into 6 parts and each part is 1 km
3. This is further divided into 10 divisions and each division is equal to 0.1 km = 1 hectometer.
   1msd = 0.1 km = 1 hectometer
   L.C expressed in terms of msd = (1/1 0) msd
   L C is 1 decameter = 1 msd - 1 vsd
   1 vsd = 1 – 1/10 = 9/10 m s d = 0.09 km
4. 9 msd are taken and divided into 10 divisions as shown. Thus 1 vsd = 9110 = 0.09 km
5. Mark on it by taking 6vsd=6x 0.9 = 0.54km, 28 msd(27 + 1 on the LHS of 1) =2.8 km and Tota12.8 + 0.54 = 3.34 km.
6. Mark on it 5 msd = 0.5 km and add to it one vsd = 0.09, total 0.59 km as marked.
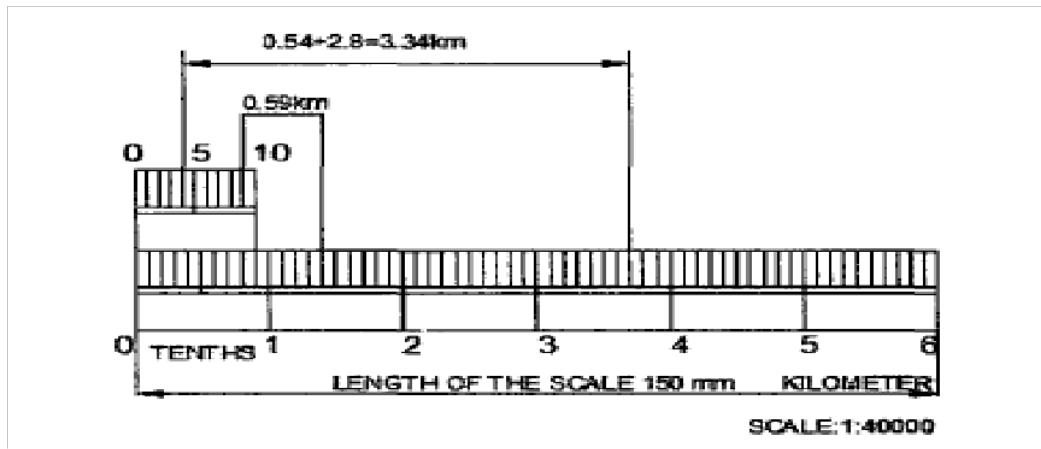
Figure.1.41

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7. *Construct a vernier scale to read meters, decimeters and centimeters and long enough to measure up to 4m. The RF of the scale in 1/20. Mark on it a distance of 2.28 m.*
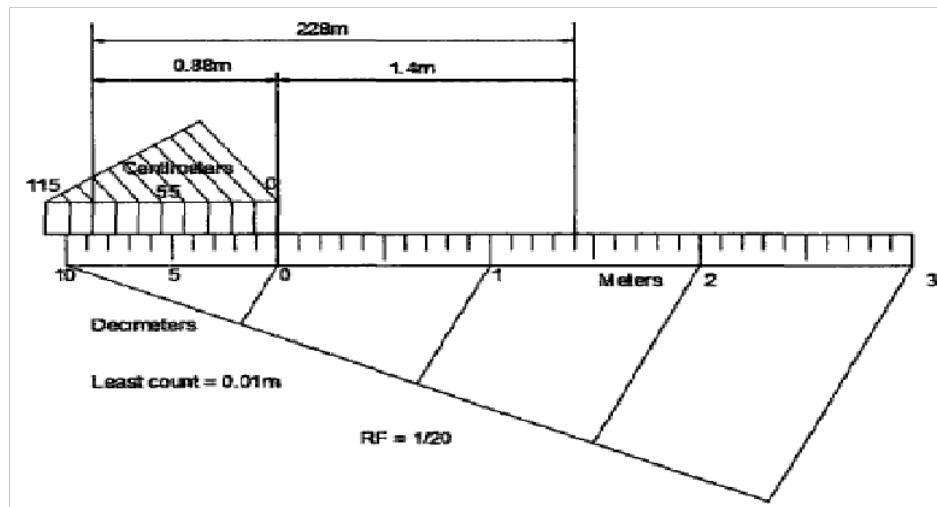
Figure.1.42

Important questions:

1. Construct a regular pentagon of 25 mm side, by two different methods.

2. On a building plan, a line of 20 cm long represents a distance of 10 m. Devise a diagonal scale for the plan to read up to 12m, showing meter, decimeter and centimeter. Represent on the scale, the lengths, 6.48 mm and 11.14 mm.

3. Construct a vernier scale to read up to 600 m. Mark on the scale a length of 549 m

4. Draw an ellipse when the distance of its vertex from its directrix is 24mm and distance of its focus from directrix is 42mm.

5. Draw the locus of a point which moves in such a manner that its distance from a fixed point its distance from a fixed straight line. Consider the distance between the fixed point and the fixed line as 60mm. Name the curve.

6. Construct a parabola if the distance between its focus and directrix is 60 mm. Also draw a tangent to the curve.

7. A vertex of a hyperbola is 50 mm from its focus. Draw two parts of the hyperbola; if the eccentricity is 3/2.

8. The focus of a hyperbola is 60mm from its directrix. Draw the curve when eccentricity is 5/3.Draw a tangent and a normal to the curve at appoint distant 45mm from the directrix.

Previous Paper Questions:

1.
   a) The actual length of 500m is represented by a line of 15 cm on a drawing. Construct a vernier scale to read upto 600 m. Mark on the scale a length of 549 m.
   b) Two fixed points A and B are 100mm apart. Trace the complete path of a point P moving in the Same plane as that of A and B in such a way that, the sum of its distances from A and B is always the same and equal to 125 mm

2.
   A coin of 40mm diameter rolls over a horizontal table without slipping. A point on the circumference of the coin in contact with the table surface in the beginning and after one complete revolution. Draw the path traced by the point. Draw a tangent and normal at a point 25 mm from the table.

3.
   a) A rectangular field of 0.54 hectare is represented on a map by a rectangle of 3cm×2cm .Draw the diagonal scale to read up to 1 meter and long enough to measure up to 600m.Mark a length of 425m.
   b) Draw a parabola when the distance between focus and directrix is 50mm. Draw a tangent and normal at a point distant 70mm from the directrix.

4.
   a) The actual length of 300m is represented by a line of 10cm on a drawing. Draw a vernier scale to read up to 500m. Mark on it a length of 367m.
   b) Draw an epi cycloid generated by a rolling circle of 60 mm diameter for one complete revolution. The radius of directing circle is 100mm.Draw a tangent and a normal to the curve at 150mm from the center of the directing circle.

5.
   a) The vertex of a hyperbola is 5cms from directrix. Draw the curve if the eccentricity is 3/2. Draw the normal and tangent at a point 50mm from axis.
   b) A circle of 30mm diameter rolls on the concave side of generating circle of radius 30mm. Draw the path traced by a point on the generating circle for one complete revolution

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UNIT – 2

PROJECTION OF POINTS AND STRAIGHT LINES

Introduction

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.

Conventional Representation:

- Actual Position of a point designated by capitals i.e. A, B, C, D …
- Front view of a point is designated by small letters with dashes i.e. a', b', c', d'….
- Top view of a point is designated by only small letters i.e. a, b, c, d ….
- Side view of a point is designated by small letters with double dashes i.e. a", b", c", d"...

The Intersection of reference planes is a line known as reference line denoted by x-y and the line connecting the front and top view is known as projection line; it is always perpendicular to the principal axis (x-y line).
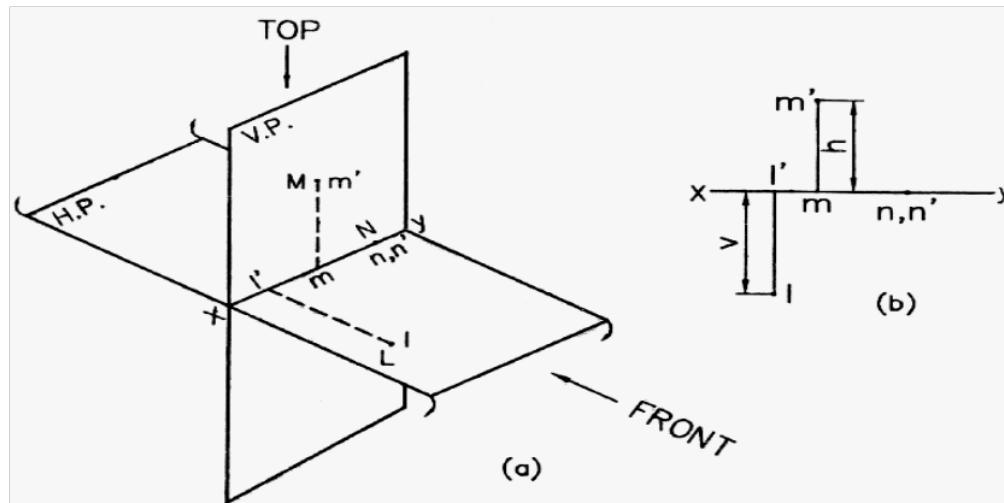
Figure 2.1

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*
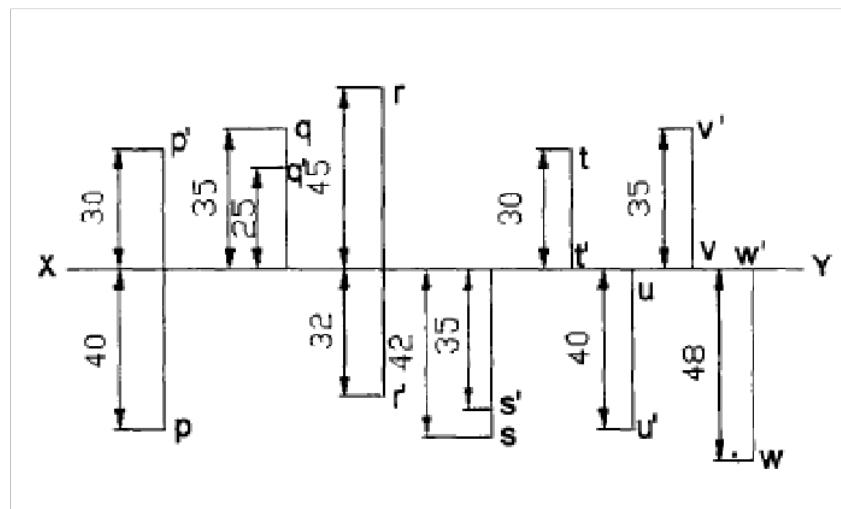
Solution:

Figure 2.2

PROJECTION OF STAIGHT LINES

Introduction

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 = 90 deg
    2. Line inclined to both H.P and V.P front view angle and top view angle = 90 deg

Problems

- **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.
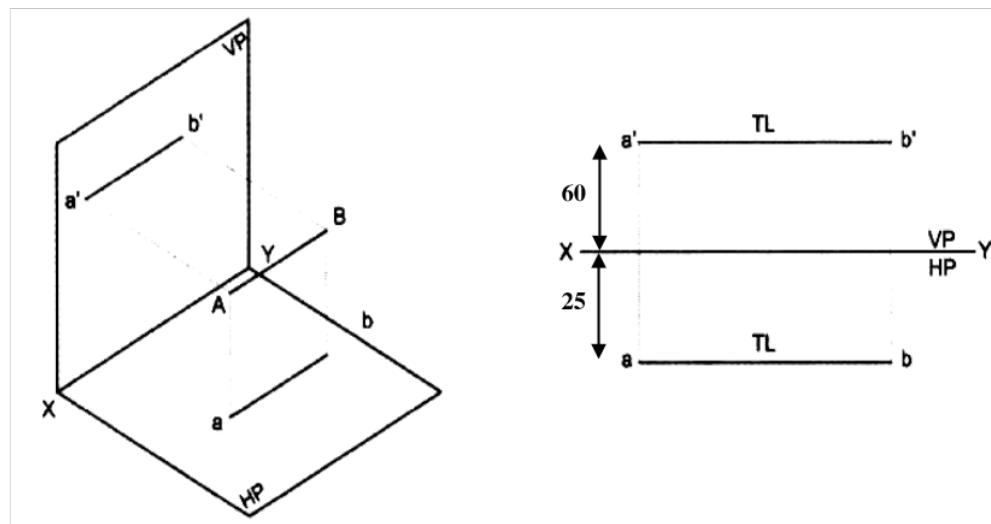
Figure 2.3

- **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.
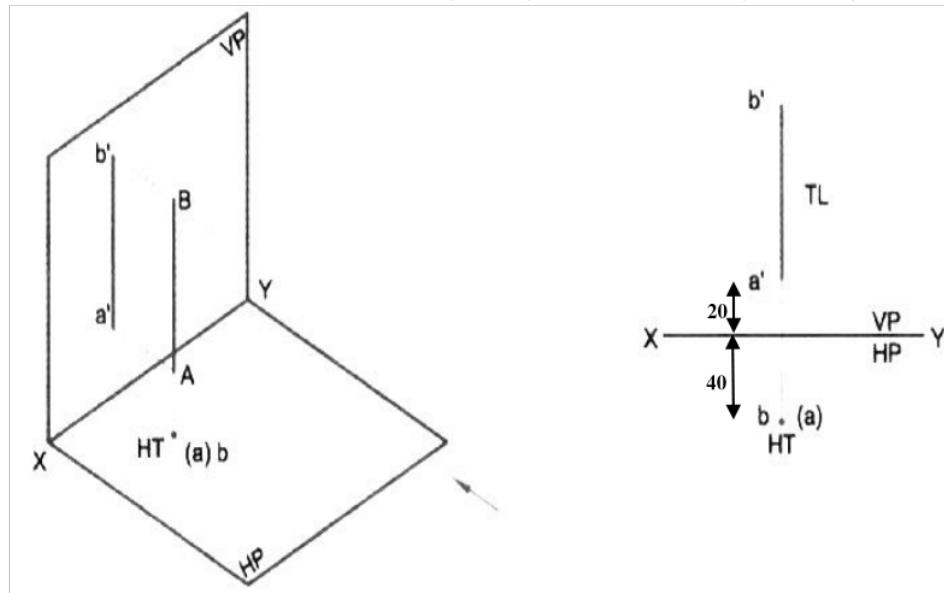
Figure 2.4

- **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.
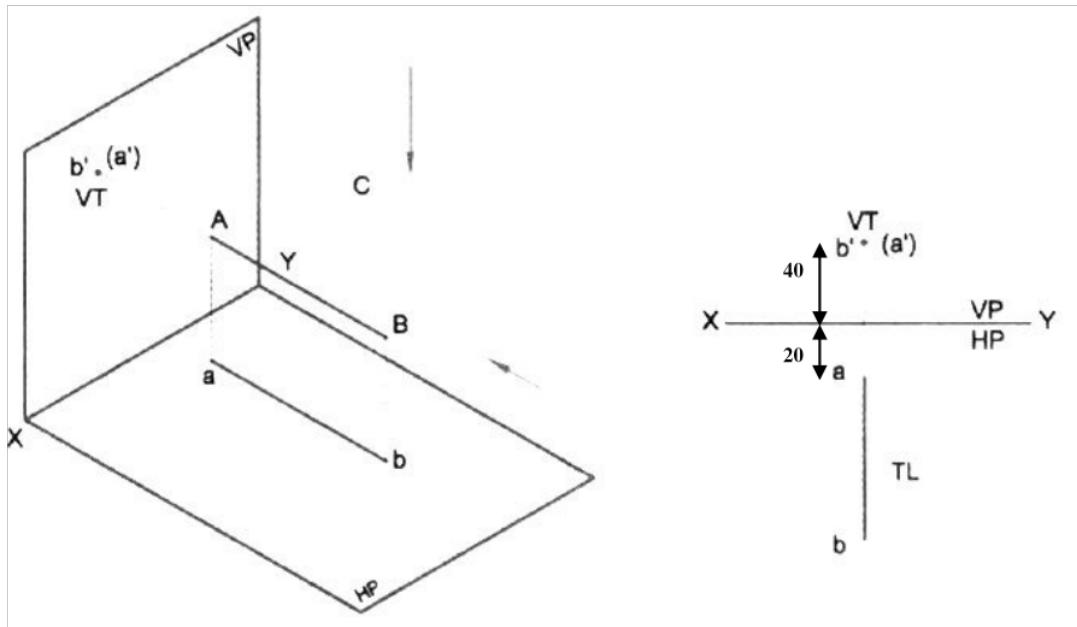
Figure 2.5

- **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.
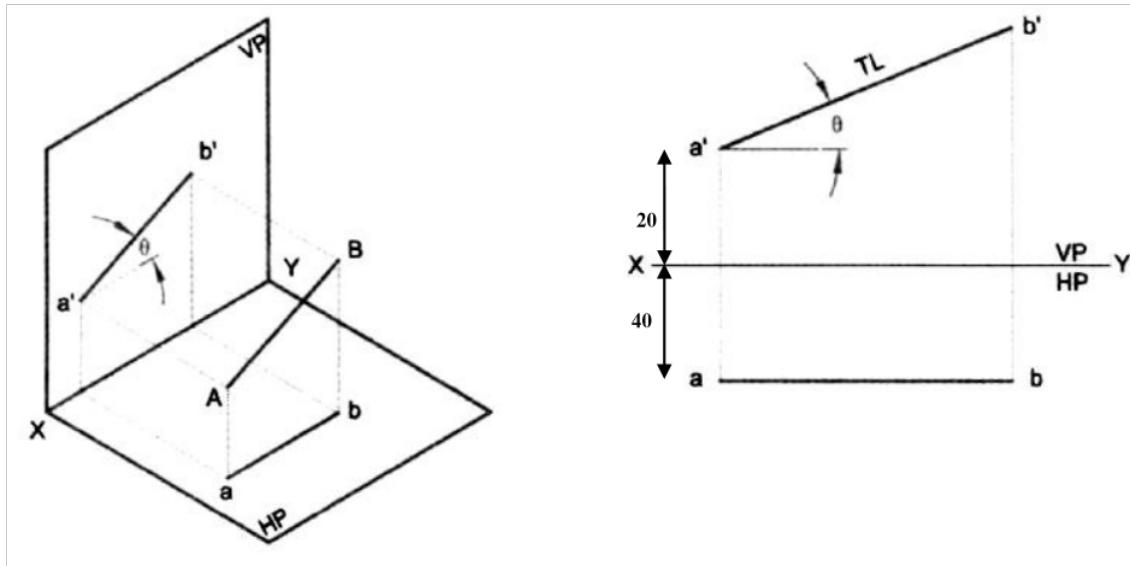
Figure 2.6

- **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.
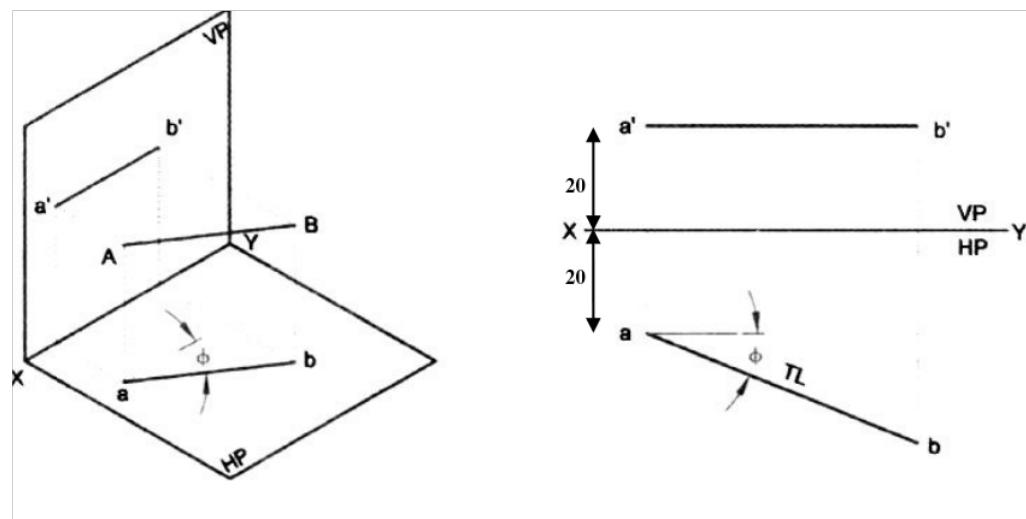
Figure 2.7

- **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.
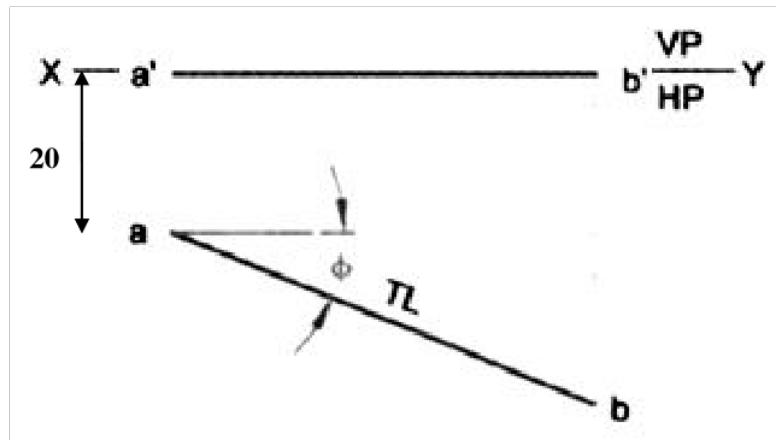
Figure 2.8

- **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.
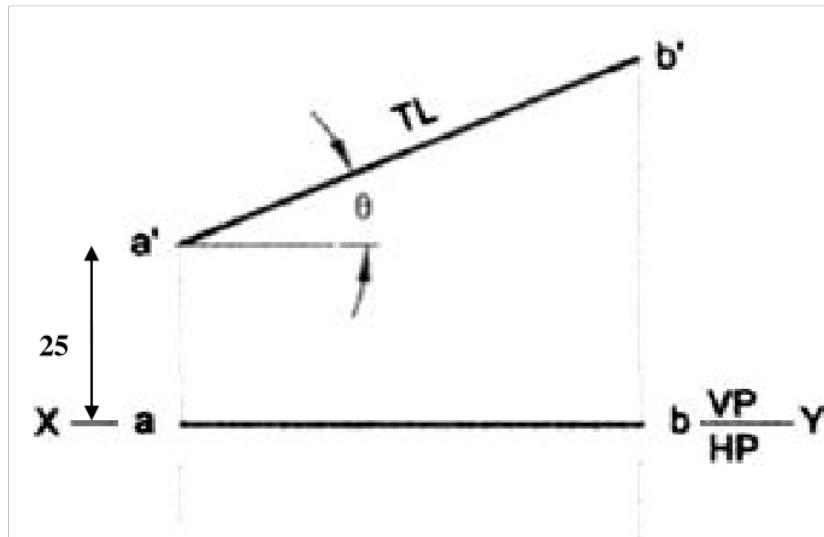
Figure 2.9

- **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.
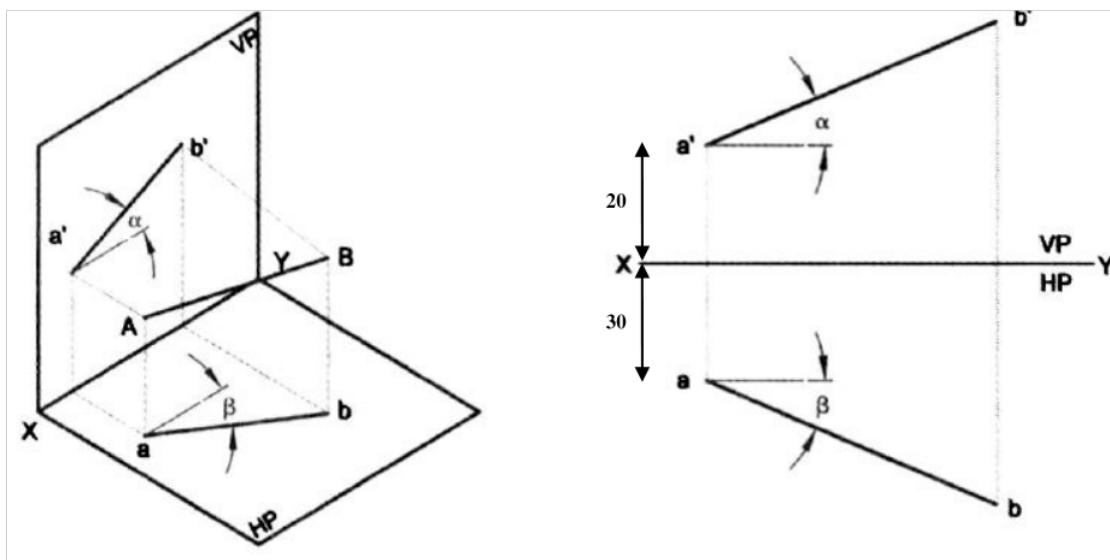
Figure 2.10

Important Questions and Previous Paper Problems:

Problem:

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

Solution:
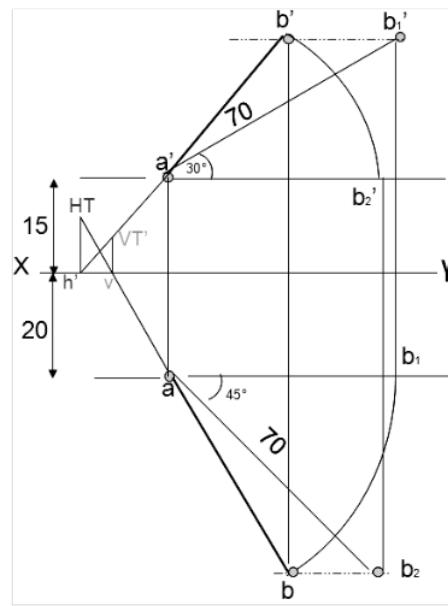
Figure 2.11

Problem:

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
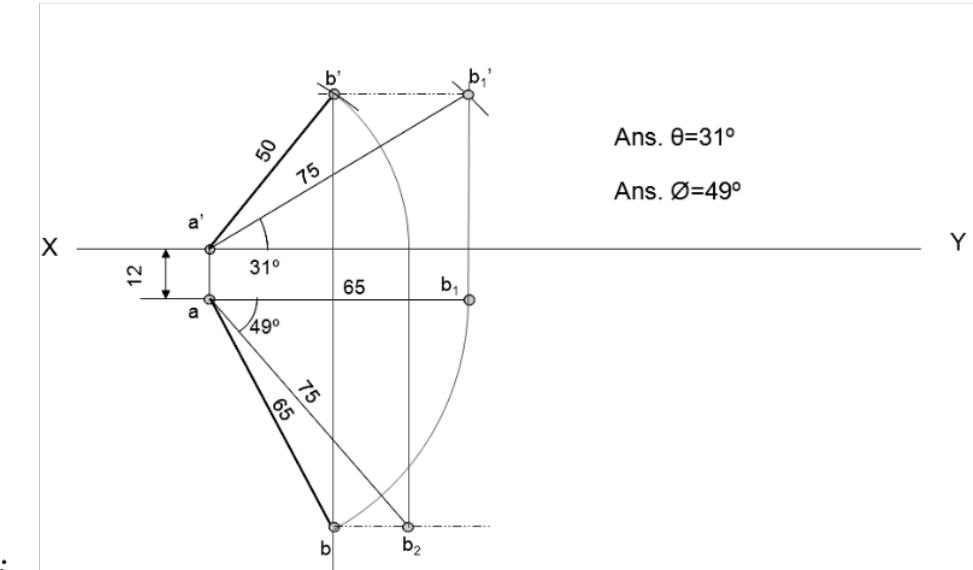
Solution:

Figure 2.12

Problem:

A line AB, 65mm long has its end A 20mm above H.P. and 25mm in front of VP. The end B is 40mm above H.P. and 65mm in front of V.P. Draw the projections of AB and shows its inclination with H.P.
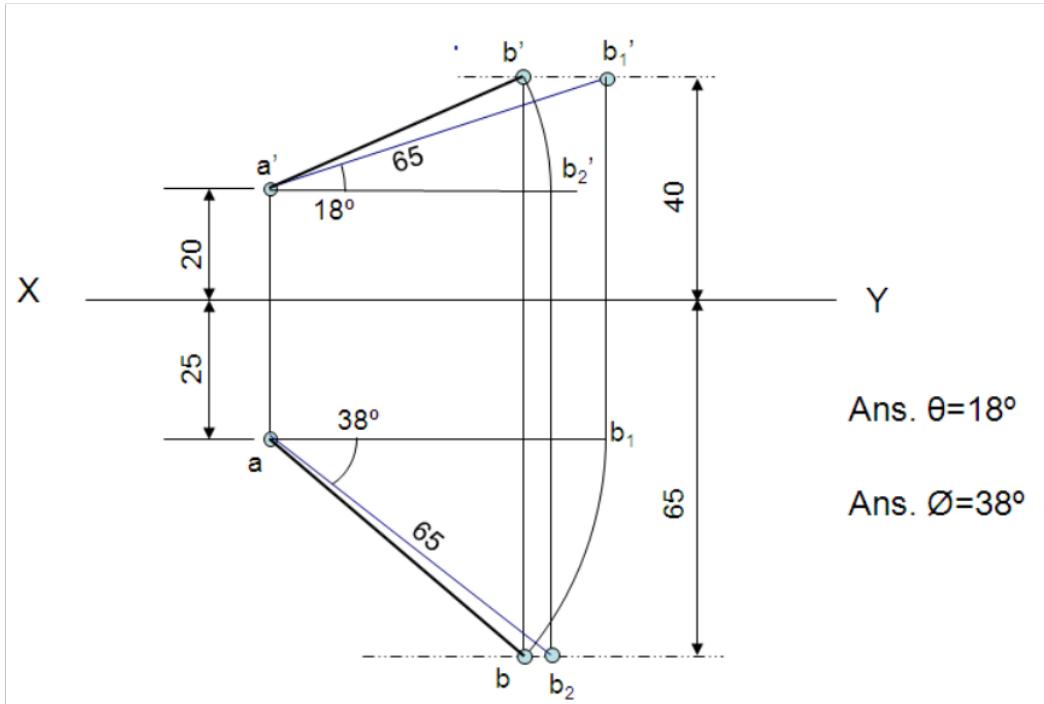
Solution:

Figure 2.13

Problem:

The projectors of the ends of a line AB are 5cm apart. The end A is 2cm above the H.P and 3cm in front of V.P. The end B is1cm below H.P. and 4cm behind the V.P. Determine the true length and traces of AB, and its inclination with the two planes.
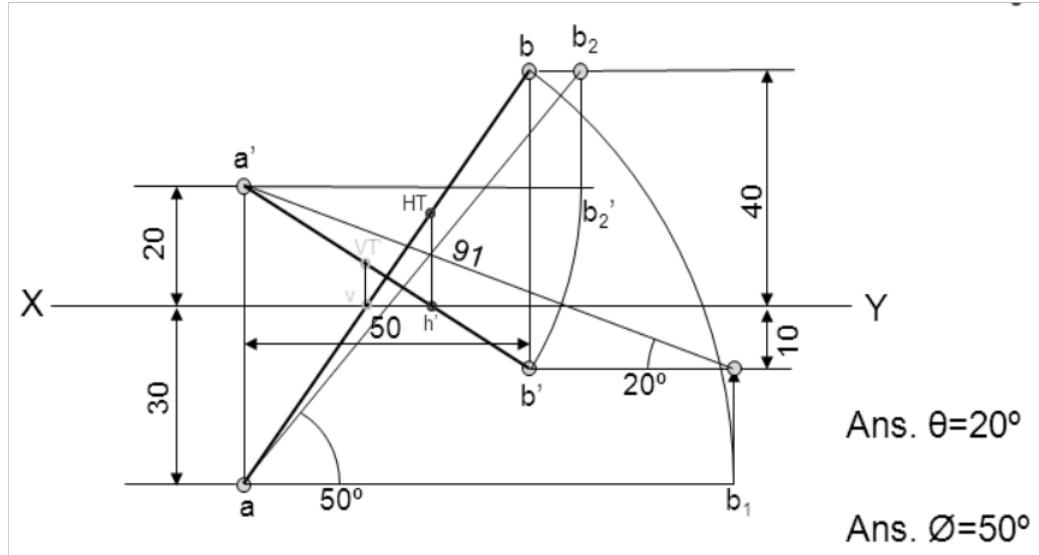
Solution:

Figure 2.14

Problem:

A line AB, 90mm long, is inclined at 45 to the H.P. and its top view makes an angle of 60 with the V.P. The end A is in the H.P. and 12mm in front of V.P. Draw its front view and finds its true inclination with the V.P.
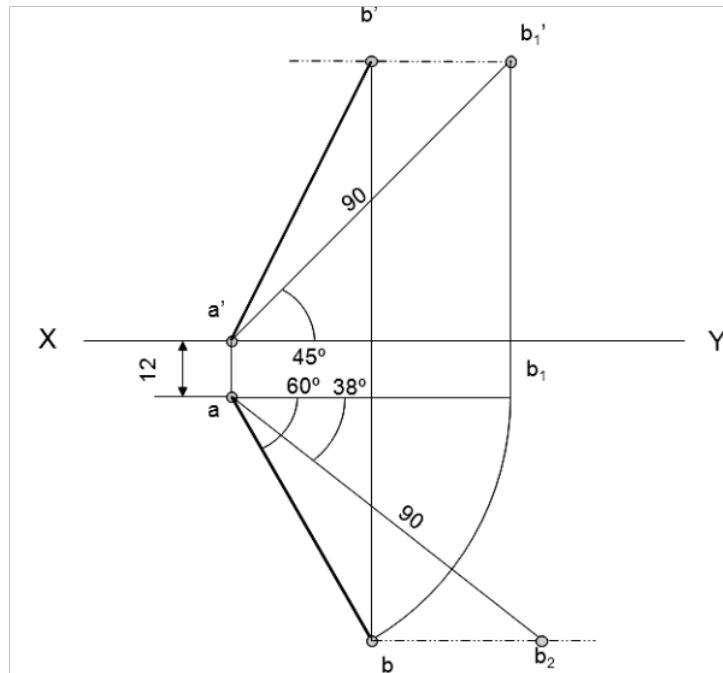
Solution:

Figure 2.15

Problem:

A line AB, 90mm long, is inclined at 30 to the HP. Its end A is 12mm above the HP and 20mm in front of the VP. Its FV measures 65mm. Draw the TV of AB and determine its inclination with the VP.
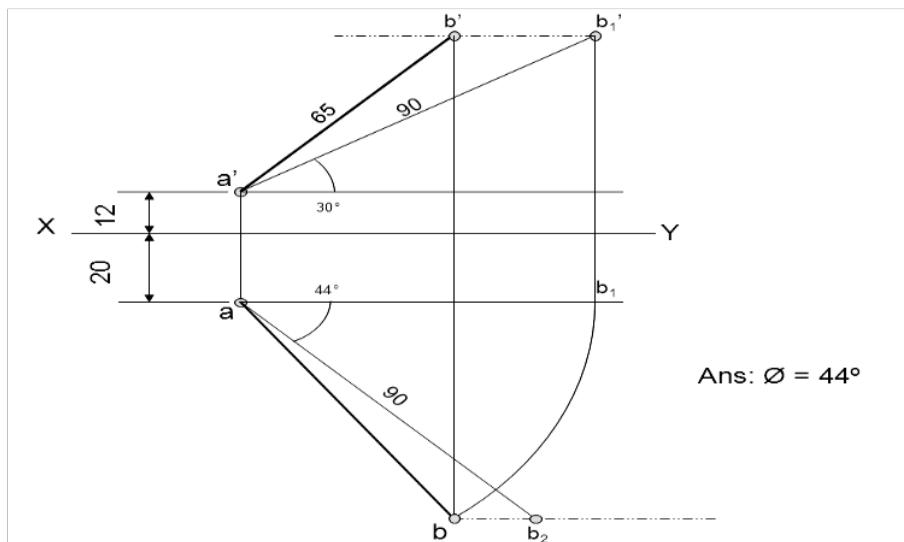
Solution:

Figure 2.16

Problem:

Two lines AB & AC make an angle of 120 deg between them in their FV & TV. AB is parallel to both the HP & VP. Determine the real angle between AB & AC.
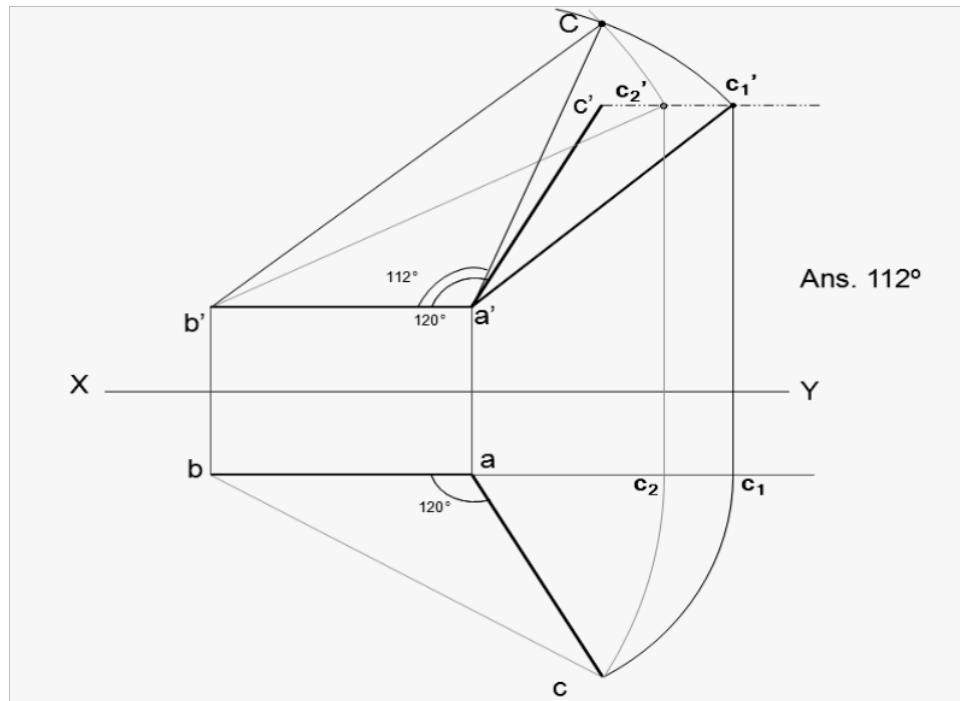
Solution:

Figure 2.17

Problem:

A line AB, inclined at 40° to the V.P. has its end 50mm and 20mm above the H.P. the length of its front view is 65mm and its V.T. is 10mm above the H.P. determine .the true length of AB its inclination with the H.P. and its H.T.
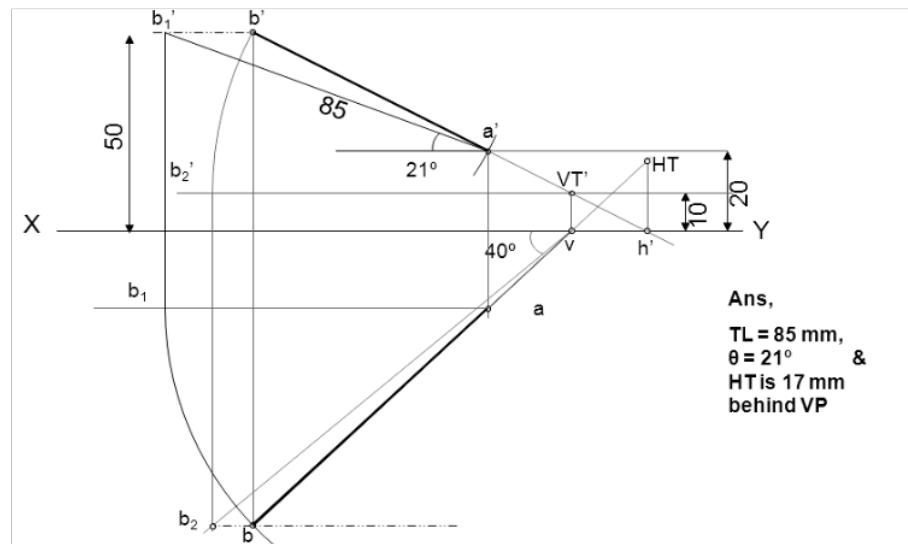
Solution:

Figure 2.18

Problem:

The top view of a 75mm long line CD measures 50 mm. C is 50 mm in front of the VP & 15mm below the HP. D is 15 mm in front of the VP & is above the HP. Draw the FV of CD & find its inclinations with the HP and the VP. Show also its traces.
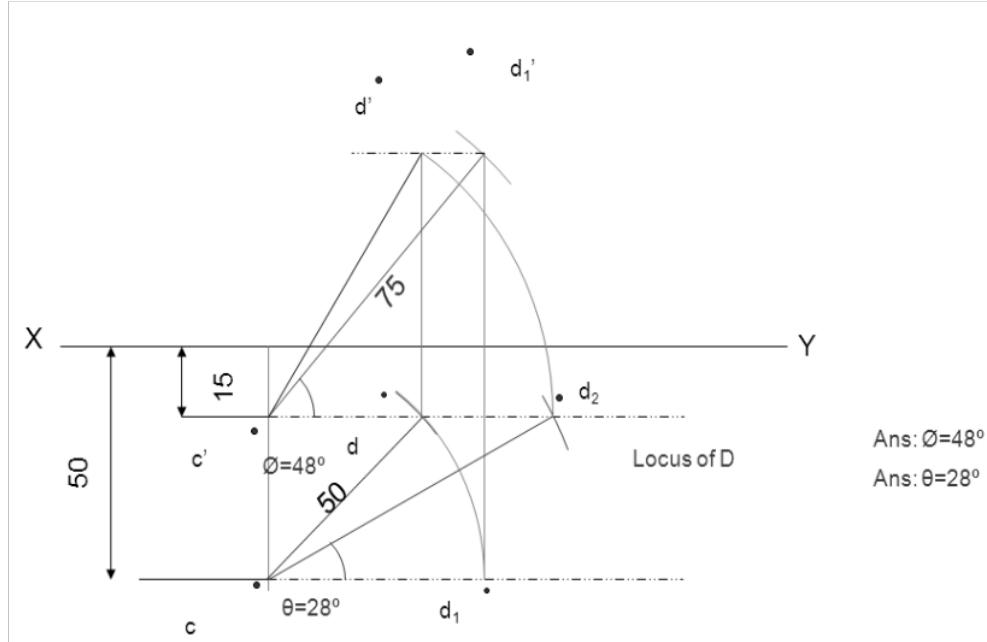
Solution:

Figure 2.19

Problem:

A line PQ 100 mm long is inclined at 30° to the H.P. and at 45° to the V.P. Its mid point is in the V.P. and 20 mm above the H.P. Draw its projections, if its end P is in the third quadrant and Q is in the first quadrant
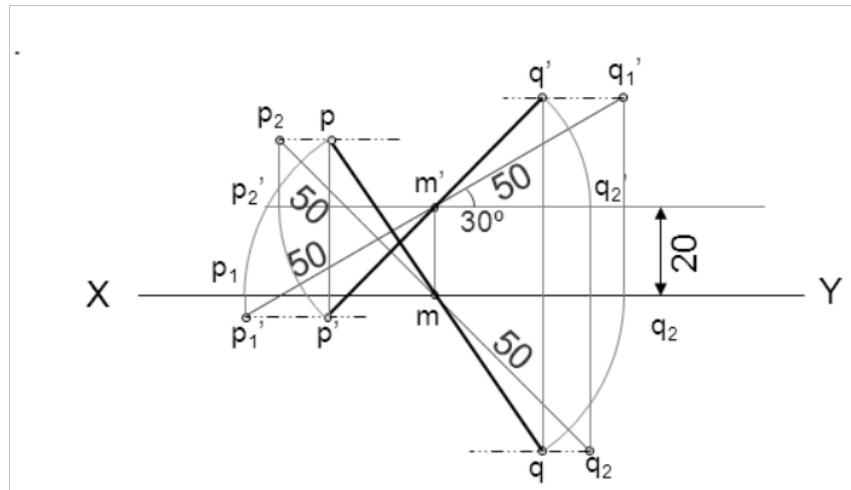
Solution:

Figure 2.20

Tips and shortcuts:

- Three different reference planes and their respective views

    Horizontal Plane, Vertical Plane and Side or Profile Plane

    Front view is a view projected on VP

    Top View is a view projected on HP and

    Side View is a view projected on PP.

- A line when parallel to both the planes HP and VP, then the line has true length in both the front and top views.
- If the line is inclined only to HP the Front view is a line having the true length (TL) and true inclination θ
- If the line is inclined only to VP the Top view is a line having the true length (TL) and true inclination Φ
- First angle projections method the objects are placed in 1st Quadrant (FV above x-y line and TV below x-y line) which is above HP and in front of VP.
- Third angle projections method the objects are placed in 3rd Quadrant (FV below x-y line and TV above x-y line) which is below HP and behind VP.

Important Questions

(1) A line PS 65mm has its end P 15mm above the HP and 15mm in front of the VP. It is inclined at 55 deg to the HP and 35 deg to the VP. Draw its projections.

(2) A line CD, inclined at 25deg to the HP, measures 80mm in top view. The end C is in the first quadrant and 25mm and 15mm from the HP and the VP respectively. The end D is at equal distance from the both the reference planes. Draw the projections, fine true length and true inclination with the VP.

(3) A straight line ST has its end S, 10mm in front of the VP and nearer to it. The mid-point M line is 50mm in front of the VP and 40mm above HP. The front and top view measure 90mm and 120mm respectively. Draw the projection of the line. Also find its true length and true inclinations with the HP and VP.

(4) A line PQ has its end P, 10mm above the HP and 20mm in front of the VP. The end Q is 85mm in front of the VP. The front view of the line measures 75mm. the distance between the end projectors is 50mm. Draw the projections of the line and find its true length and its true inclinations with the VP and HP.

(5) A line PF, 65mm has its end P, 15mm above the HP and 15mm in front of the VP. It is inclined at 55deg to the VP. Draw its projections.

Previous Paper Questions:

(1) A line CD 60mm long has its end 'C' in both H.P and V.P. It is inclined at 30^0 to H.P and 45^0 to V.P. Draw the projections.

(2) A point C is 40mm below H.P and 20mm behind V.P, another points D and E are 60mm above H.P and in front of V.P, 90mm below H.P and 45mm in front of V.P respectively. Draw the projections of all points on same reference line.

(3) The end P of a straight line PQ is 20 mm above the H.P. and 30 mm in front of V.P. The end Q is 15 mm below the H.P. and 45mm behind the V.P. If the end projectors are 50 mm apart, Draw the projection of PQ and determine the true length, traces and inclination with the reference planes.

(4) The front view of line inclined at 30^0 to V.P is 65mm long. Draw the projections of a line, when it is parallel to and 40mm above H.P. and one end being 20mm in front of V.P.

(5) A line PQ, 64 mm long has one of its extremities 20 mm in front VP and the other 50 mm above HP. The line is inclined at 40^0 to HP and 25^0 to VP. Draw its top and front view.

(6) The projection of a line AB has 35^0 inclination in top view and 40^0 inclination in the front view with an elevation length of 60 mm. If the end A is 10 mm below HP and B is 12 mm behind VP, Draw the projections and locate the traces keeping the line in the third quadrant.

(7) Line PQ has 72 mm length in the front view and 66 mm length in the top view. The end P is 48 mm below HP and 40 mm behind VP, while the end Q is 12 mm below HP. Draw the projection of the line, locate the traces and determine the true length and inclinations of the line with the reference planes.

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UNIT-3

PROJECTION OF PLANES

Introduction :

A plane is a two dimensional object having length and breadth only. Its thickness is always neglected; various shapes of plane figures are considered such as square, rectangle, circle, pentagon, hexagon, etc
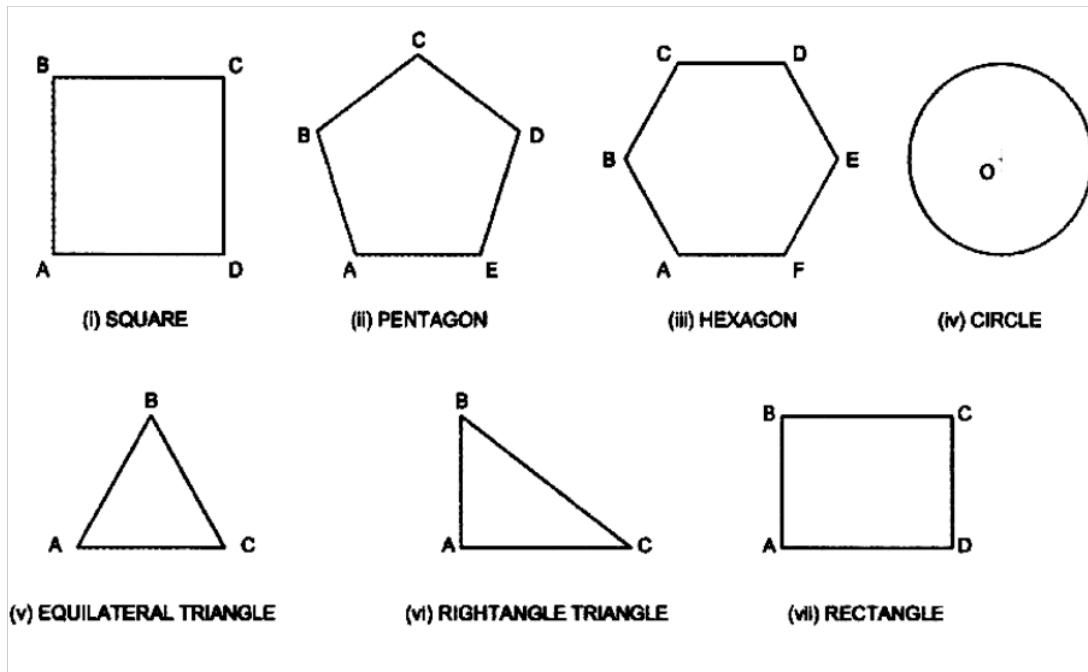
Figure 3.1

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.

Projection of Different Planes position with respective to Principal planes

1) Surface of Plane Parallel to the HP (and perpendicular to VP)
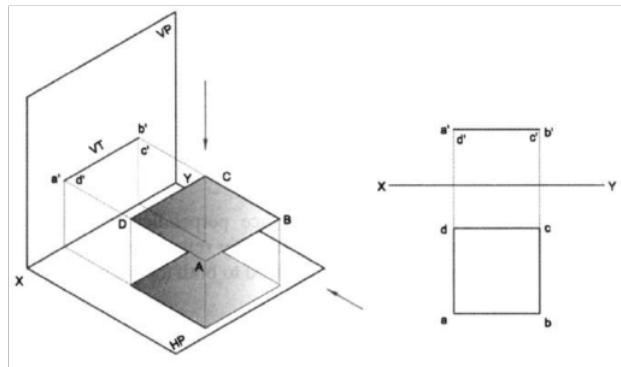
Figure 3.2

2) Surface of Plane Parallel to the VP (and perpendicular to HP)
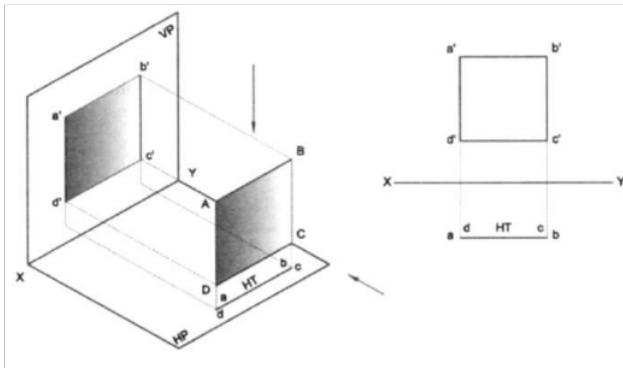
Figure 3.3

3) Surface of Plane Inclined to the HP and perpendicular to VP
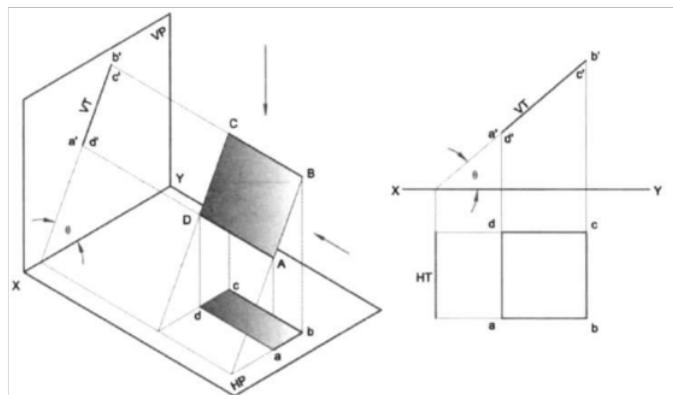
Figure 3.4

4) Surface of Plane Inclined to the VP and perpendicular to HP
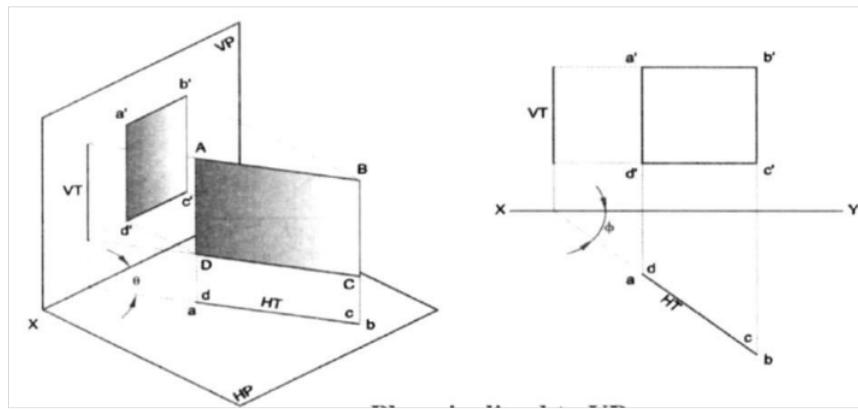
Figure 3.5

5) Surface of Plane Perpendicular to Both HP and VP
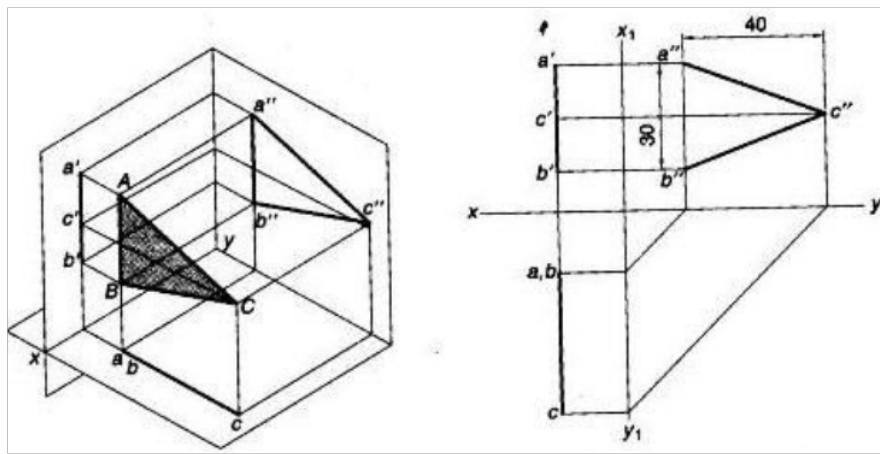
Figure 3.6

6) Surface of Plane is Inclined to Both HP and VP
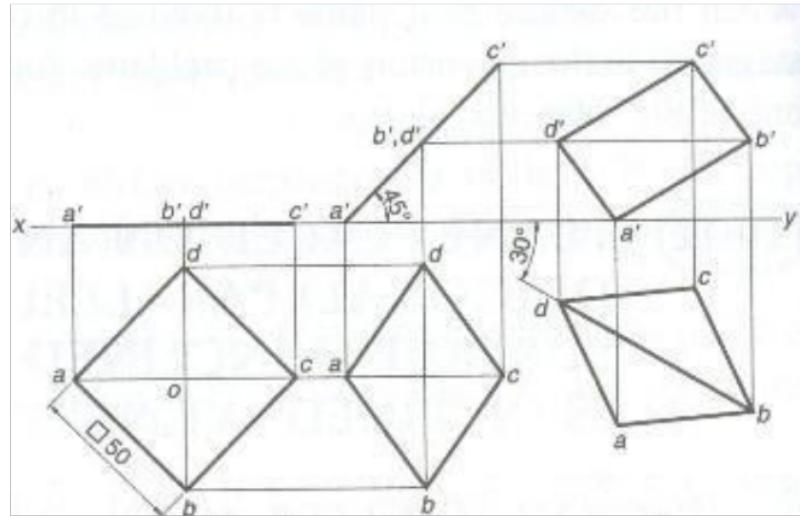
Figure 3.7

Simple Problems:

Plane Parallel to HP

Problem: *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.*

Visualized position of surface plane Picture:
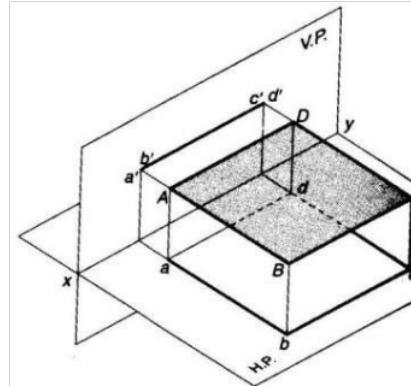
Figure 3.8(a)

Solution:

(a)   (b)   (c)
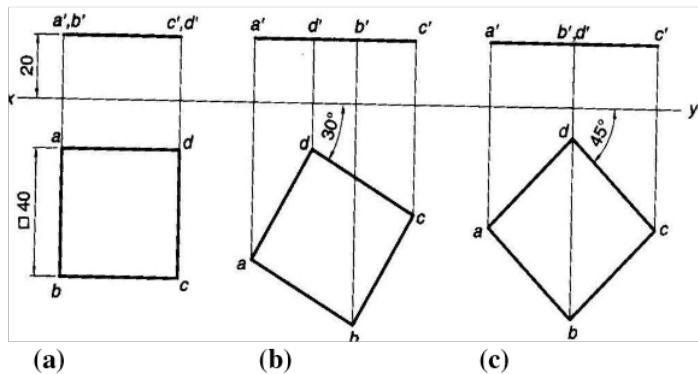
Figure 3.8(b)

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 45⁰ to the HP

Visualized position of surface plane Picture:
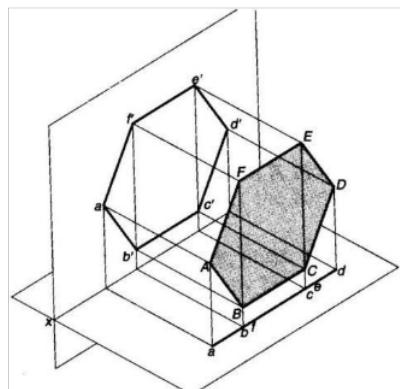
Figure 3.9(a)

Solution:

(a)   (b)   (c)
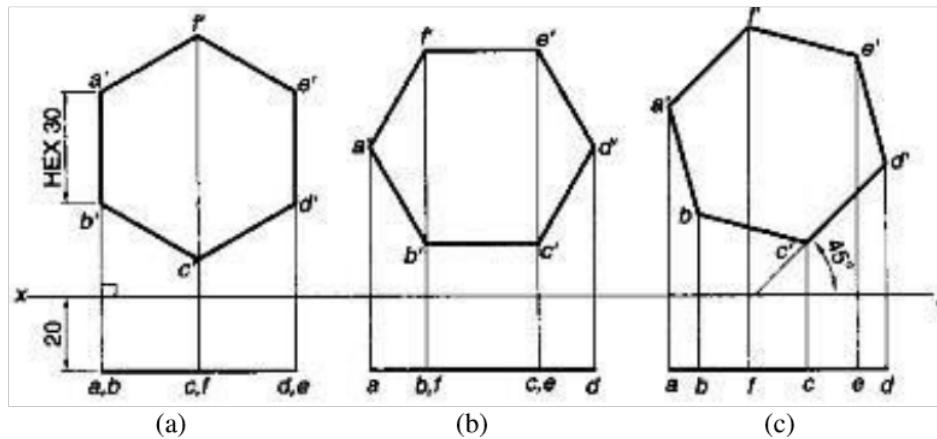
Figure 3.9(b)

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 45⁰ to the HP. Draw it's Projections?

Visualized position of surface plane Picture:
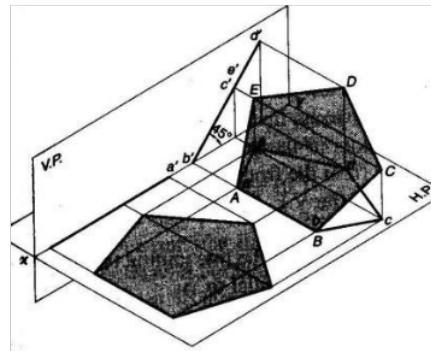
Figure 3.10(a)

Solution:
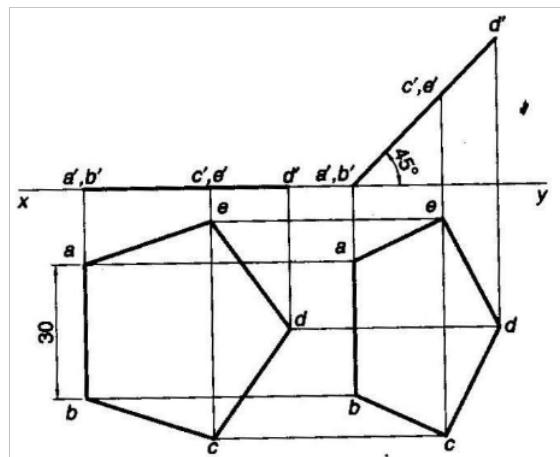
Figure 3.10(b)

Plane is inclined to VP and Perpendicular to HP

Problem:
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

Visualized position of surface plane Picture:
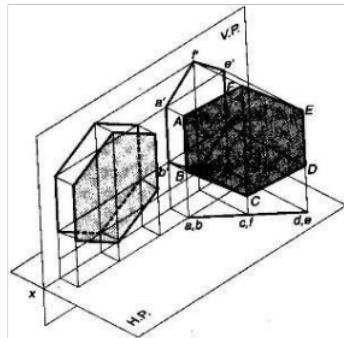
Figure 3.11(a)
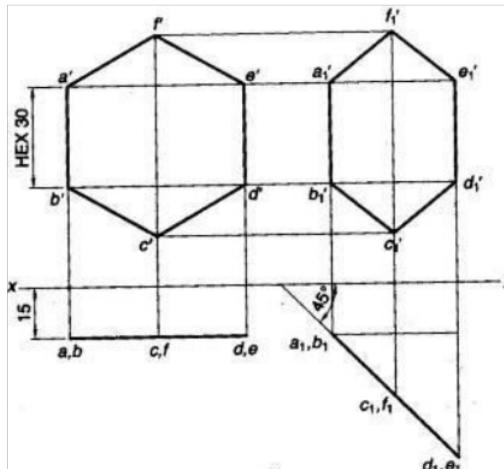
Solution:

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 45⁰ to the VP. And perpendicular to the HP Draw It's Projections?
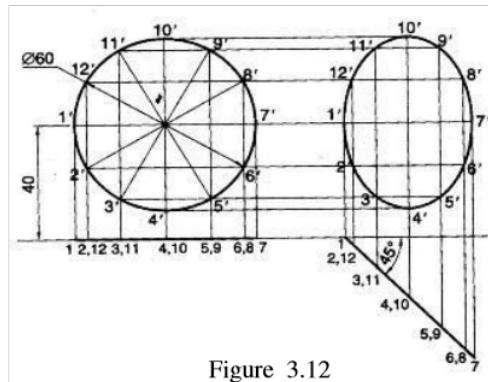
Solution:

Figure 3.12

Problem:

Rectangle 30mm and 50mm sides is resting on HP on one of its small side which is 30^0 inclined to VP, while the surface of the plane makes 45^0 inclination with HP. Draw it's projections?
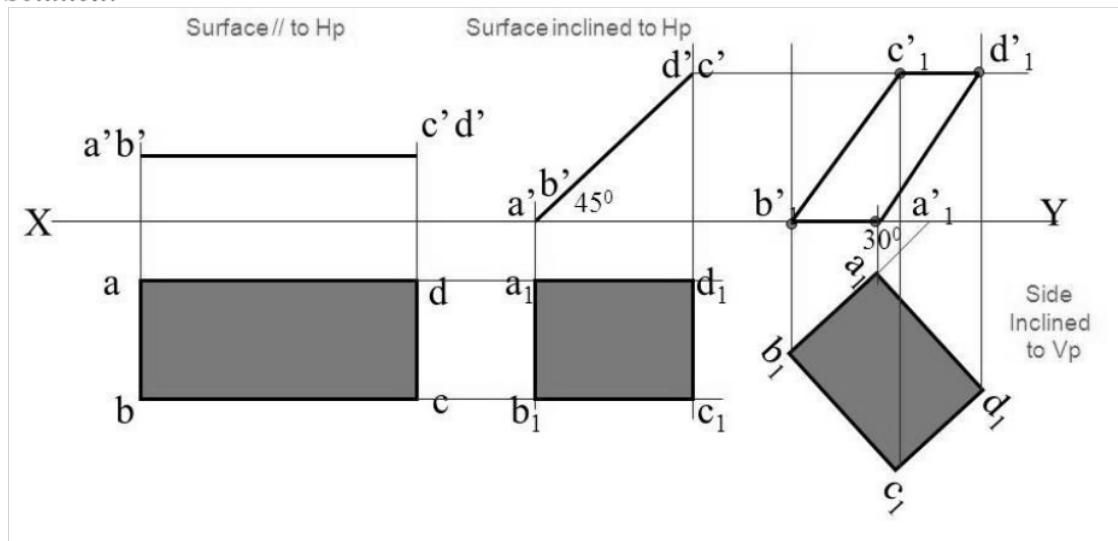
Solution:

Figure 3.13

Problem:

A regular pentagon of 30 mm sides is resting on HP, on one of it's sides with it's surface 45^0 inclined to HP. Draw it's projections when the side in HP makes 30^0 angle with VP?

Solution:

According to the given Problem
1. Surface inclined to HP plane
2. Assumption for initial position is parallel to HP
3. So TV view will show True shape. Hence begin with TV, draw pentagon below   X-Y line, taking one side vertical.
Note: Surface and side inclination are directly given
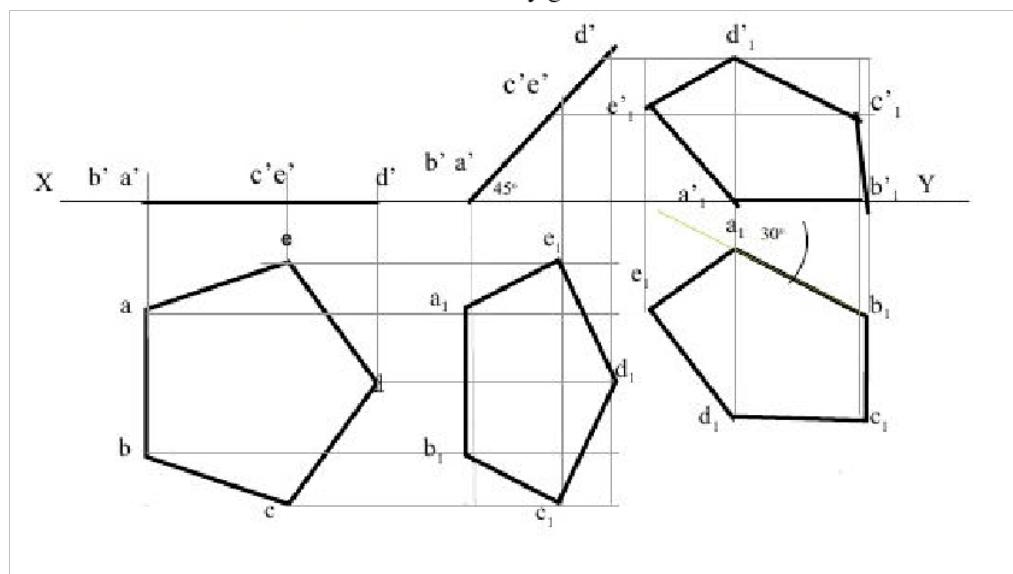
Figure 3.14

Problem:

A regular pentagon of 30 mm sides is resting on HP on one of it's sides while it's opposite vertex (corner) is 30 mm above HP. Draw projections when side in HP is 30^0 inclined to VP

Solution:

According to the given Problem

      1. Surface inclined to HP plane

      2. Assumption for initial position is parallel to HP

      3. So TV view will show True shape . Hence begin with TV, draw pentagon below   X-Y line, taking one side vertical.

Note: Surface Inclination indirectly given and side inclination is Directly given only change is the manner in   which surface inclination is described: One side on Hp & it's opposite corner 30 mm above HP .Hence redraw 1st Fv as a 2nd Fv making above arrangement. Keep a'b' on xy & d' 30 mm above xy
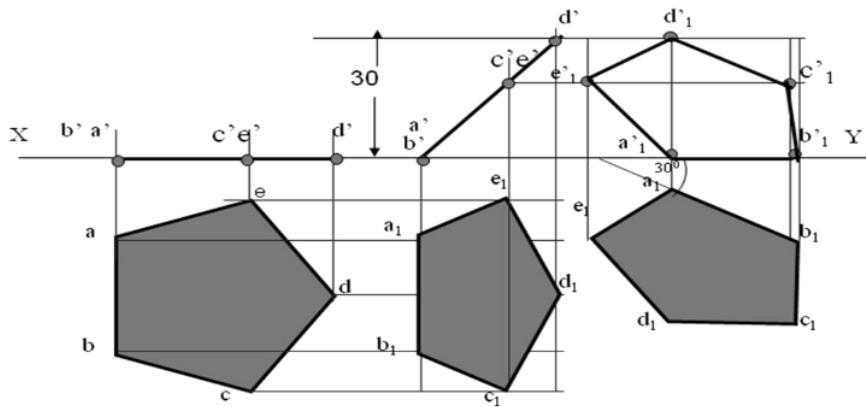
Figure 3.15

Problem:

A circle of 50 mm diameter is resting on HP on end A of it's diameter AC which is 30^0 inclined to HP while it's TV is 45^0 inclined to VP. Draw it's Projections?

Solution:

According to the given Problem

1. Surface inclined to HP plane

2. Assumption for initial position parallel to HP

3. So which TV will show True shape

4. Which diameter AC horizontal Hence begin with TV, draw rhombus below X-Y line, taking longer diagonal parallel to X-Y

      Note: In This problem inclination of TV of that AC is given, It could be drawn directly as shown in 3rd step. of that AC is given, It could be drawn directly as shown in 3rd step.
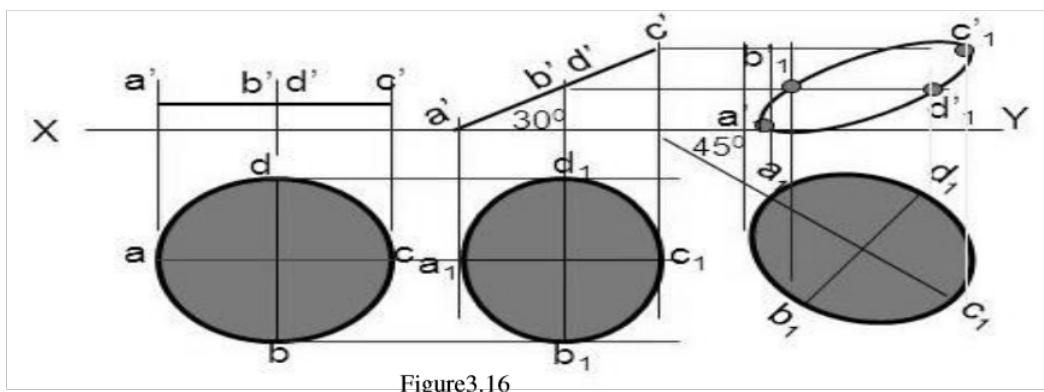
Figure3.16

Problem:

A semicircle of 100 mm diameter is suspended from a point on its straight edge 30 mm from the midpoint of that edge so that the surface makes an angle of 45⁰ with VP. Draw its projections.

Solution:

According to the given Problem:

1. In this case the plane of the figure always remains perpendicular to HP
2. It may remain parallel or inclined to VP
3. Hence TV in this case will be always a LINE view.
4. Assuming surface Parallel to VP, draw true shape in suspended position as FV. (Here keep line joining point of contact & centroid of fig. vertical)
5. Always begin with FV as a True Shape but in a suspended position. AS shown in 1st FV.

Note: First draw a given semicircle with given Diameter, Locate its centroid position And join it with point of suspension.
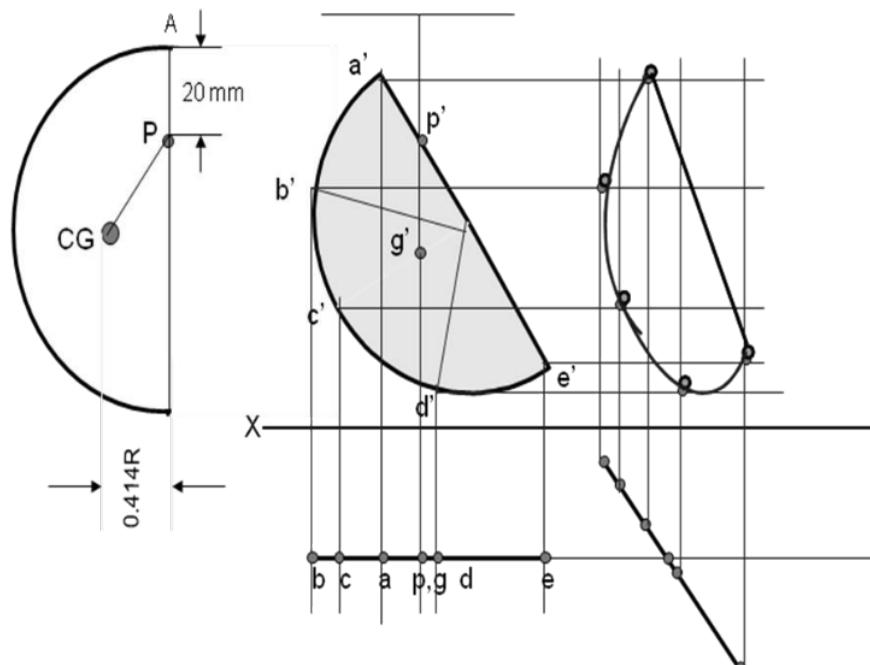
Figure 3.17

Tips and Shortcuts:

i) Plane is inclined to HP and perpendicular to VP ⟶ has to solve in two stages

Stage 1: Assume the plane is parallel to HP ⟶ Draw its Top View and Front View

Stage2: Tilt the Front View to given angle ⟶ Project all the points we get the second Top view

ii) Plane is inclined to VP and perpendicular to HP ⟶ has to solve in two stages

Stage 1: Assume The plane is parallel to VP ⟶ Draw its Front View and Top View

Stage2: Tilt the Top View to given angle ⟶ Project all the points we get the second Front view

Important Questions:

1. A pentagon of sides 30mm rests on the ground on one of its corners with the sides containing the corners being equally inclined to the ground. The side opposite to the corner on which it rests is inclined at 30 degrees to the VP and is parallel to the HP. The surface of the pentagon makes 10 degrees with the ground. Draw the top and front views of the pentagon.

2. A regular pentagon of 30mm side is resting on one of its edges on HP which is inclined at 45degrees to VP. Its surface is inclined at 30 degrees to HP. Draw its projections.

Previous Paper Questions:

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1. Draw the projections of a regular hexagon of 25mm side, having one of its sides in the H.P. and inclined at 60 degrees to the V.P., and its surface making an angle of 45 degrees with H.P.

2. A thin circular plate of 40mm diameter having its plane vertical and inclined at 40^0 to V.P. Its center is 30mm above H.P. and 35mm in front of V.P. Draw the projections.

PROJECTION OF SOLIDS

Introduction:

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

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) The nomenclature of the prism is given in Fig.

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

Group A	Group B
Solids having top and base of same shape	Solids having base of some shape and just a point as a top, called apex.

Cylinder

Cone

Prisms

Pyramids

Triangular   Square   Pentagonal   Hexagonal

Triangular   Square   Pentagonal   Hexagonal

Cube
(A solid having six square faces)

Tetrahedron
(A solid having Four triangular faces)
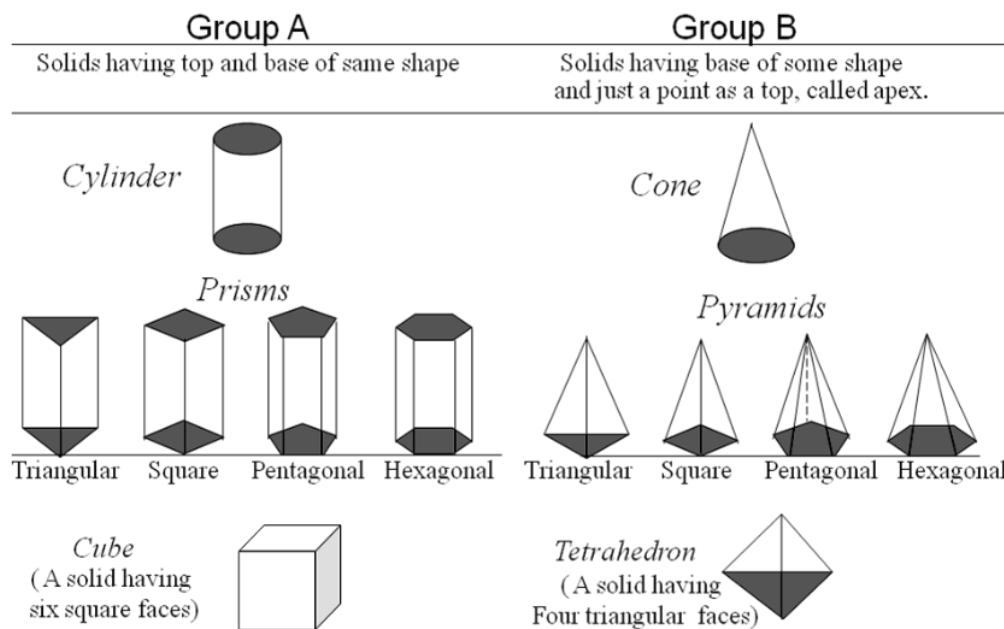
Figure 3.18

(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 has eight equal faces, each an equilateral triangle.
(d) **Dodecahedron**: It has twelve regular and equal pentagonal faces.
(e) **Icosahedrons**: It has twenty equal, equilateral triangular faces.

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

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

Dimensional parameters of different solids.
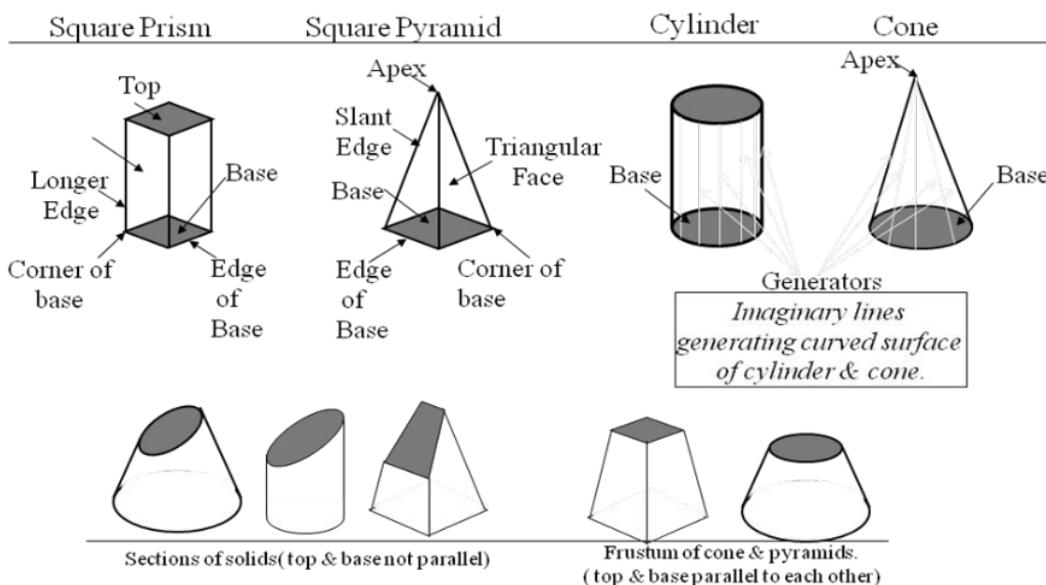
Figure 3.19

Types of Pyramids:

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

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

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

Prisms Position of a Solid with Respect to the Reference Planes: The position of solid in space may be specified by the location of either the axis, base, edge, diagonal or face with the principal planes of projection. The following are the positions of a solid considered.

1. **Axis perpendicular to HP**
2. **Axis perpendicular to VP**
3. **Axis parallel to both the HP and VP**
4. **Axis inclined to HP and parallel to VP**
5. **Axis inclined to VP and parallel to HP**
6. **Axis inclined to both the Planes (VP. and HP)**
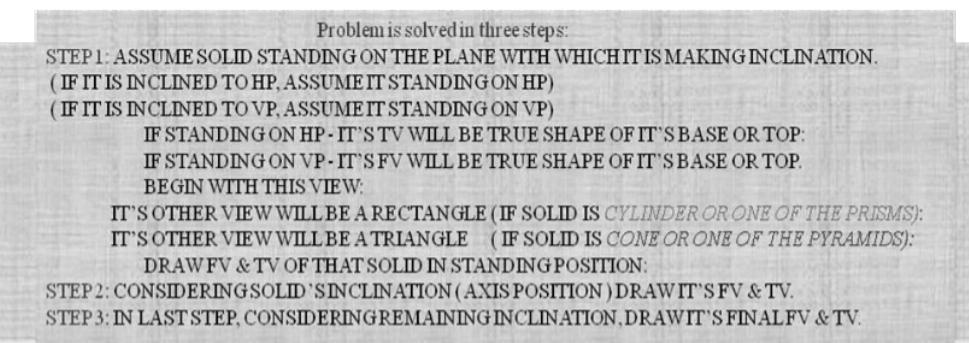
The position of solid with reference to the principal planes may also be grouped as follows:
1.   Solid resting on its base.
2.   Solid resting on anyone of its faces, edges of faces, edges of base, generators, slant edges, etc.
3. Solid suspended freely from one of its corners, etc.

1. Axis perpendicular to one of the principal planes:

When the axis of a solid is perpendicular to one of the planes, it is parallel to the other. Also, the projection of the solid on that plane will show the true shape of the base.

When the axis of a solid is perpendicular to H.P, the top view must be drawn first and then the front view is projected from it. Similarly when the axis of the solid is perpendicular to V.P, the front view must be drawn first and then the top view is projected from it.
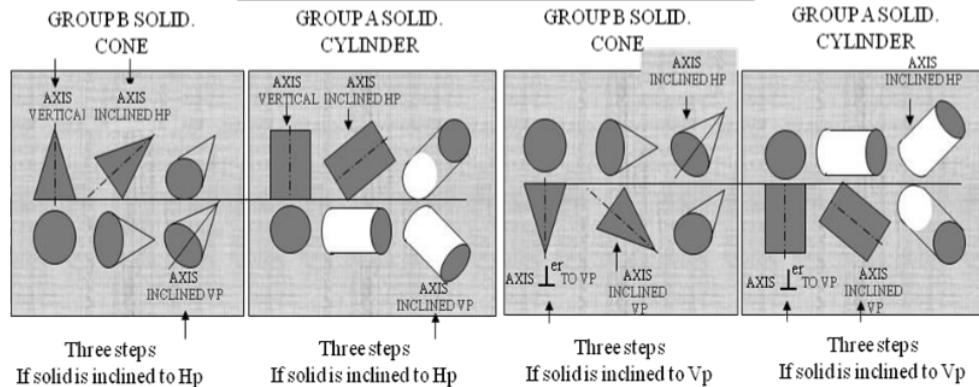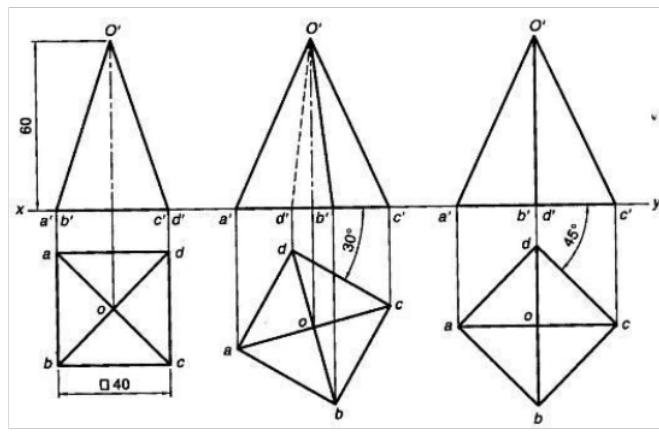
Figure 3.20

Simple Problems:

When the axis of solid is perpendicular to one of the planes, it is parallel to the other. Also, the projection of the solid on that plane will show the true shape of the base. When the axis of a solid is perpendicular to H.P, the top view must be drawn first and then the front view is projected from it. Similarly when the axis of the solid is perpendicular to V.P, the front view must be drawn first and then the top view is projected from it.

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 30⁰ to the VP and (c) All the sides of base are equally inclined to the VP.

Solution:

(a)   (b)   (c)

Figure 3.21

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 45⁰ to the HP

Solution:

(a)   (b)   (c)
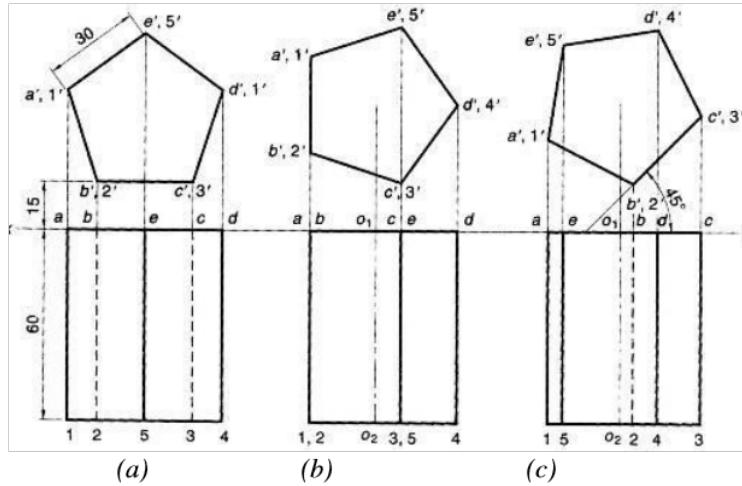
Figure 3.22

3. Axis parallel to both the HP and VP

Problem:
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?
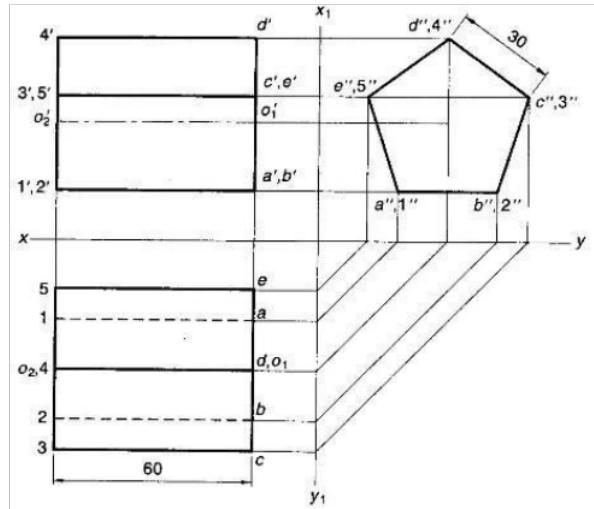
Solution:

Figure 3.23

4. Axis inclined to HP and parallel to VP

Problem:
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?

Solution:
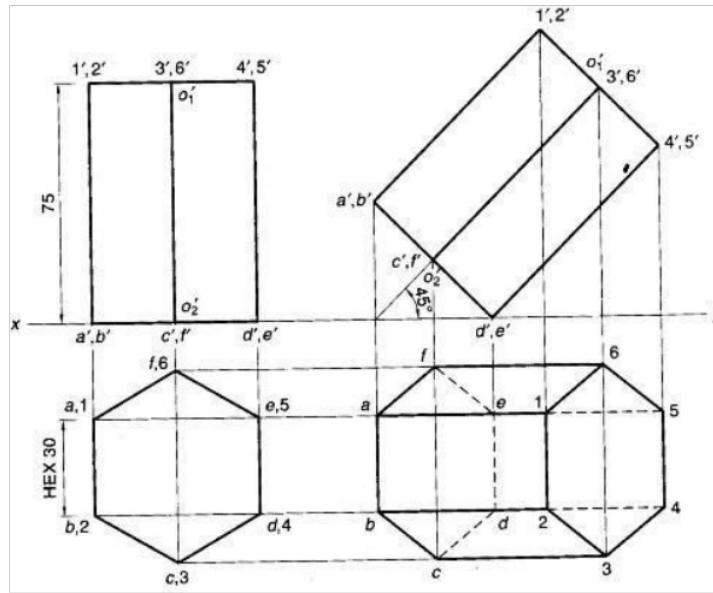
Figure 3.24

5. Axis inclined to VP and parallel to HP

Problem:
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?

Solution:
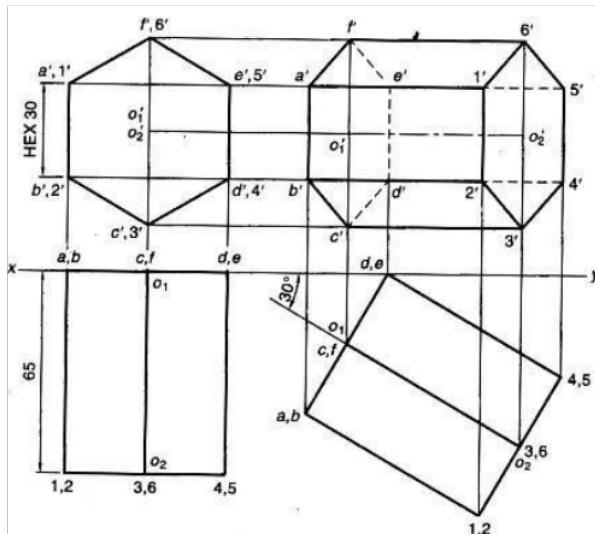
Figure 3.25

6. Axis inclined to both the principal planes (HP and VP)

A solid is said to be inclined to both the planes when (i) the axis is inclined to both the planes, (ii) the axis is inclined to one plane and an edge of the base is inclined to the other. In this case the projections are obtained in three stages.
Stage I: Assume that the axis is perpendicular to one of the planes and draw the projections.
Stage II: Rotate one of the projections till the axis is inclined at the given angle and project the other view from it.
Stage III: Rotate one of the projections obtained in Stage II, satisfying the remaining condition and project the other view from it.

Problem:
A cube of 50 mm long edges is so placed on HP on one corner that a body diagonal is Parallel to HP and perpendicular to VP. Draw it's projections.

Solution Steps:
1. Assuming standing on HP, begin with TV, a square with all sides equally inclined to xy .Project Fv and name all points of FV & TV.
2. Draw a body-diagonal joining c' with 3' (This can become Parallel to xy)
3. From 1' drop a perpendicular on this and name it p'
4. Draw 2ⁿᵈ Fv in which 1'-p' line is vertical means c'-3' diagonal must be horizontal. .Now as usual project TV..
5. In final TV draw same diagonal is perpendicular to VP as said in problem. Then as usual project final FV.
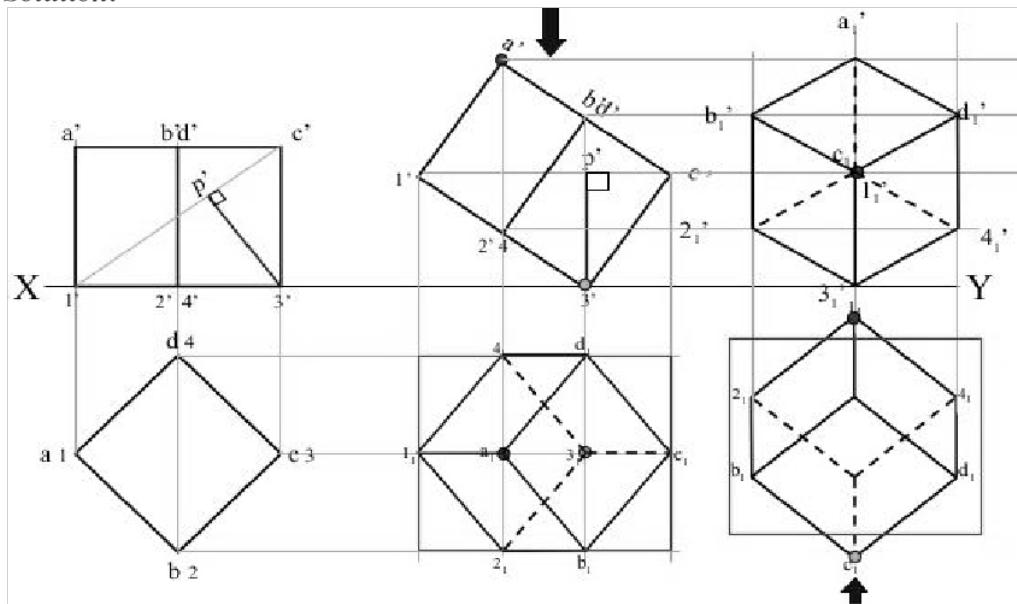
Solution:

Figure 3.26

Problem:

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?

Solution Steps:

Resting on HP on one generator, means lying on HP

1. Assume it standing on HP.
2. It's TV will show True Shape of base(circle)
3. Draw 40mm dia. Circle as TV& taking 50 mm axis project FV. (a triangle)
4. Name all points as shown in illustration.
5. Draw 2ⁿᵈ FV in lying position I.e. o'e' on xy. And   project it's TV below xy.
6. Make visible lines dark and hidden dotted, as per the procedure.
7. Then construct remaining inclination with VP (generator o_1e_1 30⁰ to xy as shown) & project final FV.
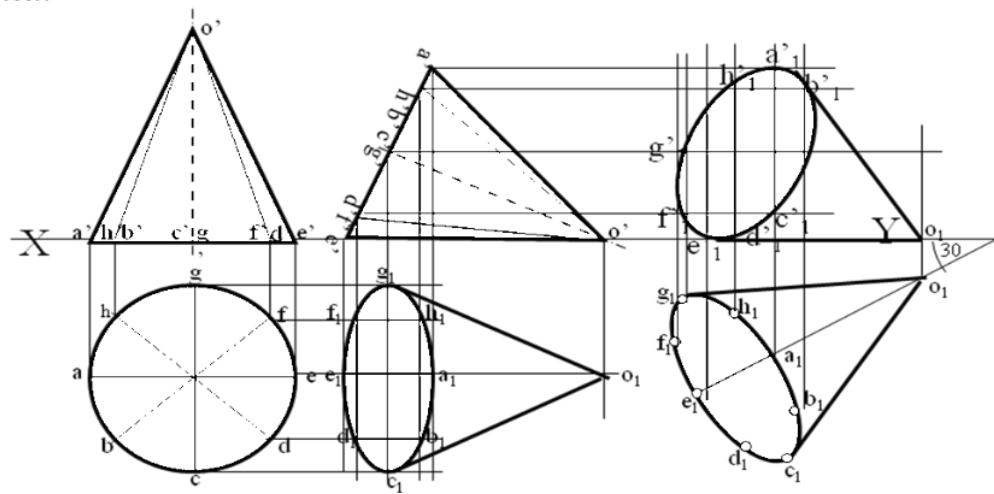
Solution:

Figure 3.27

Problem:
A cube of 50 mm long edges is so placed on HP on one corner that a body diagonal through this corner is perpendicular to HP and parallel to VP. Draw it's three views.

Solution Steps:
1. Assuming it standing on HP begin with TV, a square of corner case.
2. Project corresponding FV.& name all points as usual in both views.
3. Join a'1' as body diagonal and draw 2nd FV making it vertical (I' on xy)
4. Project it's TV drawing dark and dotted lines as per the procedure.
5. With standard method construct Left-hand side view.(Draw a 45^0 inclined Line in Tv region (below xy).Project horizontally all points of Tv on this line and reflect vertically upward, above xy.After this, draw horizontal lines, from all points of Fv, to meet these lines. Name points of intersections and join properly.For dark & dotted lines locate observer on left side of Fv as shown.)
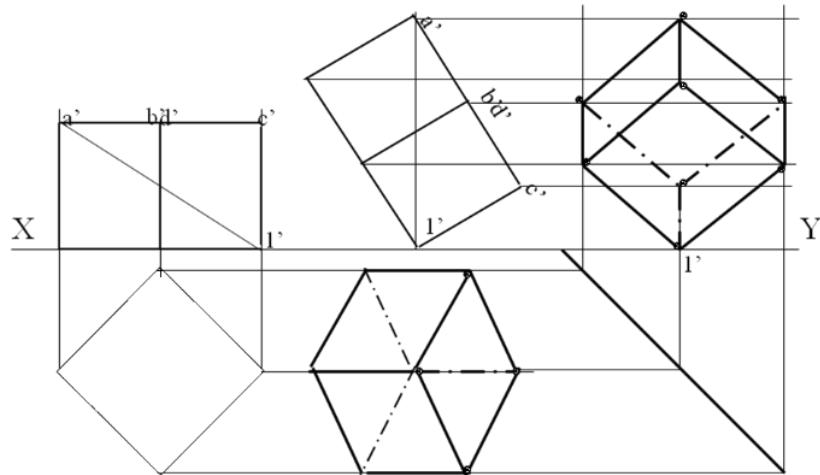
Solution:

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.
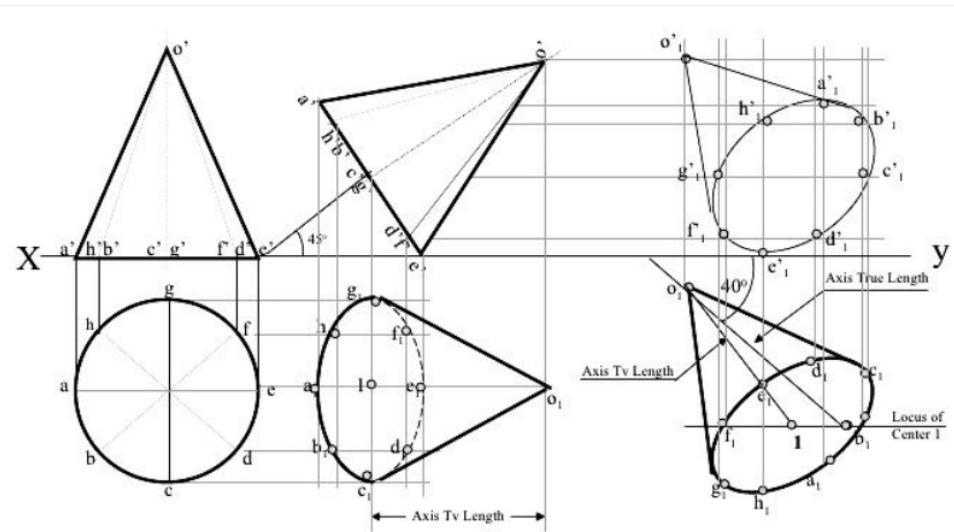
Solution:

Figure 3.29

Problem:

A hexagonal prism, having a base with a 30mm side and an 80mm long axis, rests on one of its base edges in the H.P such that the axis is inclined at 30^0 to the HP and 45^0 to the VP. Draw its projections?
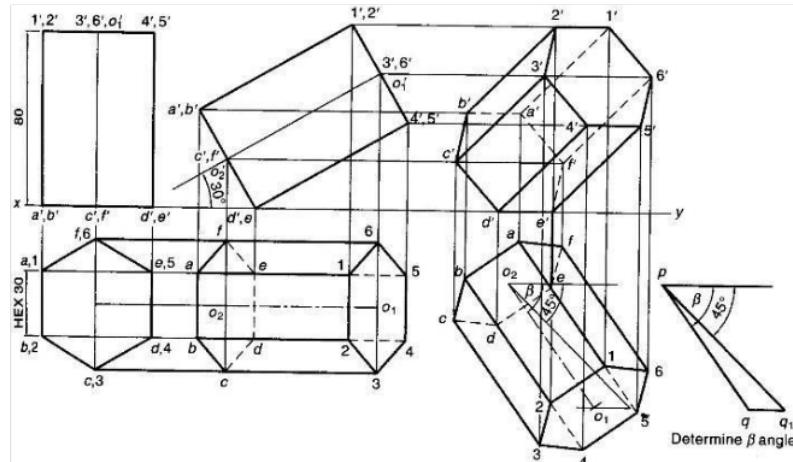
Solution:

Figure 3.30

Problem:

A Square prism, having a base with a 35mm side and an 60mm long axis, rests on one of its base edges in the HP such that the axis is inclined at 45^0 to the HP and 45^0 to the VP. Draw its projections, if the resting edge makes an angle of 30^0 with VP?
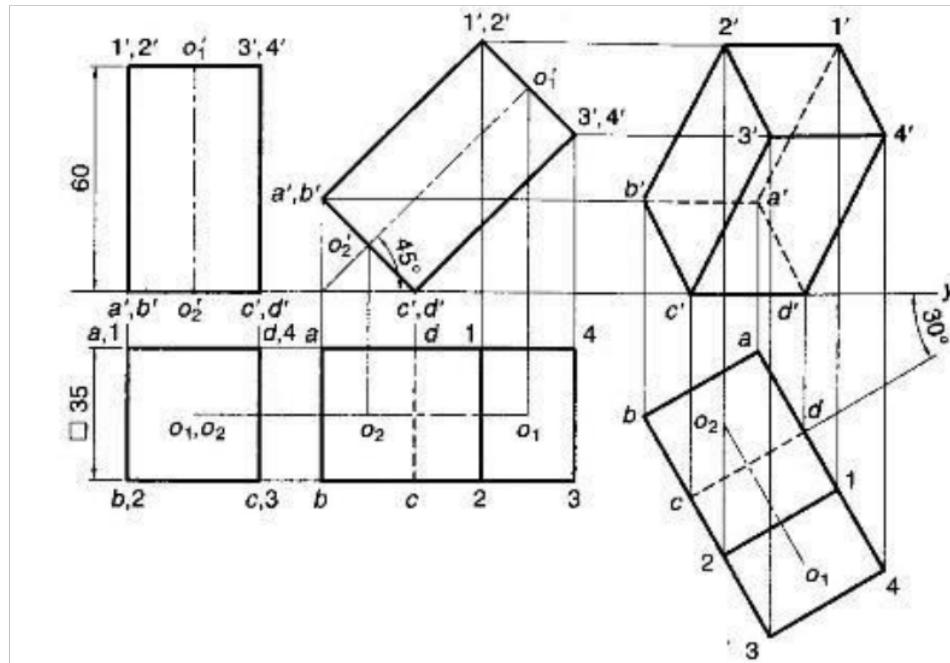
Solution:

Figure 3.31

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 45⁰ with VP and FV of the axis 35⁰ 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 2ⁿᵈ TV making axis 45⁰ 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.
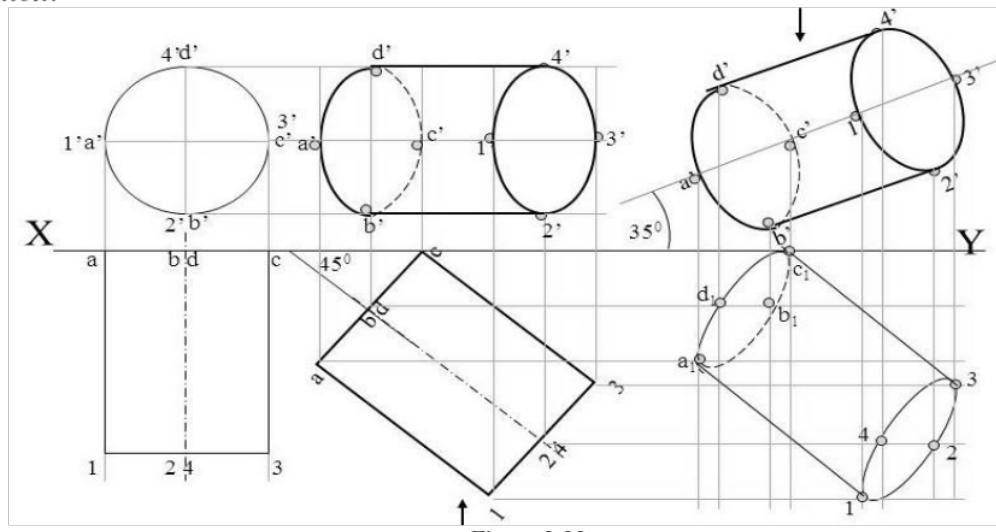
Solution:

Figure 3.32

Problem:

A hexagonal prism of base side 30 mm long and axis 40 mm long, is standing on HP on it's base with one base edge parallel to VP.A tetrahedron is placed centrally on the top of it. The base of tetrahedron is a triangle formed by joining alternate corners of top of prism. Draw projections of both solids. Project an auxiliary TV on AIP 45⁰ inclined to HP
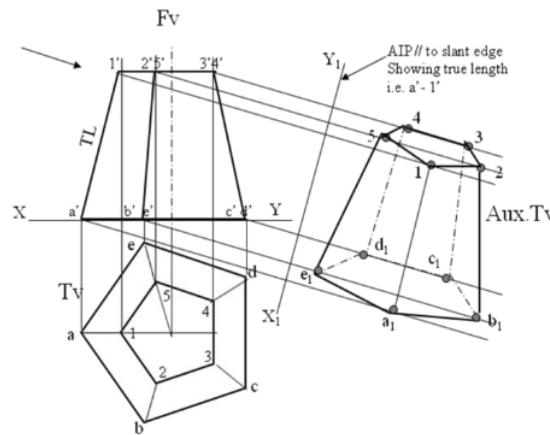
Solution:

Figure 3.33

Tips &Shortcuts:

1.Axis inclined to HP and Parallel to VP ⟶ have to solve in two stages
Stage(i) assume axis perpendicular to HP then draw Top and Front view
Stage(ii) Tilt the Front view according to given angle. Then project all the points will get Final Top view

2 Axis inclined to VP and Parallel to HP ⟶ have to solve in two stages
Stage(i) assume axis perpendicular to VP then draw front and Top view
Stage(ii) Tilt the Top view according to given angle. Then project all the points will get Final Front view

Previous paper questions and Important Problems:

1. A cone of base diameter 40 mm and axis height 60 mm rests on the ground on a point of its base circle such that the axis of the cone is inclined at 40^0 to the HP and 30^0 to the VP. Draw its front and top views.

2. A hexagonal prism of base of side 40 mm and axis length 80 mm rests on one of its base edges on the HP. The end containing that edge is inclined at 30^0 to the HP and the axis is parallel to VP. It is cut by a plane perpendicular to the VP and parallel to the HP. The cutting plane bisects the axis. Draw its front and the sectional top views.

3. A square pyramid of base side 30 mm and altitude 50 mm lies on one of its triangular faces on the HP with its axis parallel to the VP. It is cut by a vertical plane inclined at 30^0 to the VP and meeting the axis at 40 mm from the vertex measured in the plan. Draw the top view, sectional front view and the true shape of the section.

4. A cone, diameter of base 50 mm and axis 65 mm long. is lying on the HP. on one of its generators with the axis parallel to the VP. It is cut by a horizontal Section plane 12mm above the ground. Draw its front view and sectional top view.

5. Draw the projections of a hexagonal pyramid of side of base 30mm and axis 60mm long resting on one of its base edges in HP with its axis inclined at 30^0 to HP. and the top view of axis is 45^0 to VP.

6. A square prism having a base with a 40mm side and a 60 mm long axis rests on its base on HP. such that one of the vertical faces makes an angle of 30 degrees with VP. A section plane perpendicular to the VP. Inclined at 45 degrees to the HP. and passing through the axis at a point 20 mm from its top end cuts the prism. Draw its front view, sectional top view.

7. A hexagonal prism, side of base 35mm and height 75mm is resting on one of its corners on HP. with a longer edge containing that corner inclined at 60 degrees to the HP. and rectangular face parallel to the VP. A horizontal section plane cuts the prism into two halves. Draw the sectional top view of the cut prism and front view.

8. Draw the projections of a pentagonal prism, base 25 mm side and axis 50 mm long resting on one of its rectangular faces on HP, with the axis inclined at 45 degrees to VP.

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UNIT – 4
ISOMETRIC AXES, LINES, PLANES AND SOLIDS

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 120^0 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. This is conveniently done by constructing an isometric scale as described on next page.

Construction of isometric scale:

From point A, with line AB draw 30^0 and 45^0 inclined lines AC & AD respective on AD. Mark divisions of true length and from each division-point draw vertical lines up to AC line. The divisions thus obtained on AC give lengths on isometric scale.

Note:

   Isometric Drawing/Isometric view ⟶ *true length*

   Isometric Projection ⟶ *Reduced length (isometric length)*
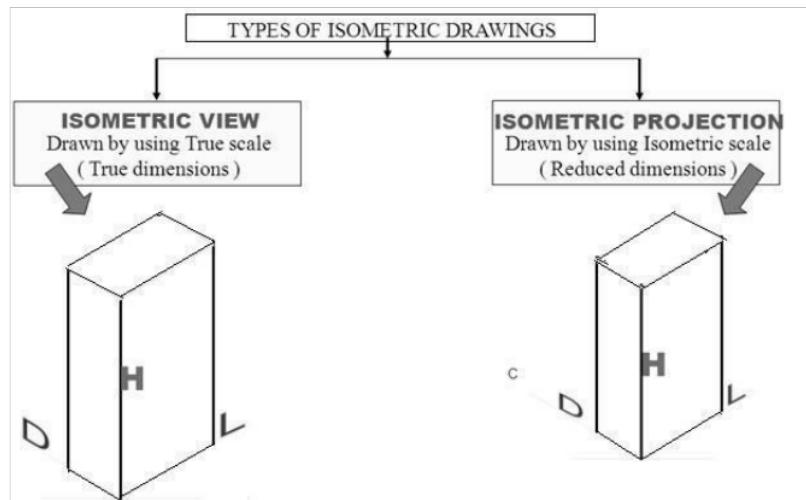
Figure 4.1

Isometric scale [Line AC] required for Isometric Projection:
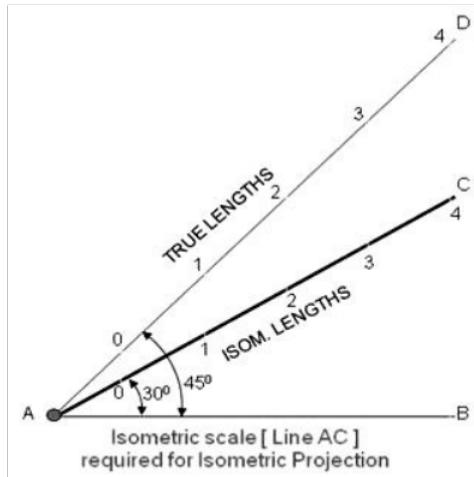
Figure 4.2

Terminology:
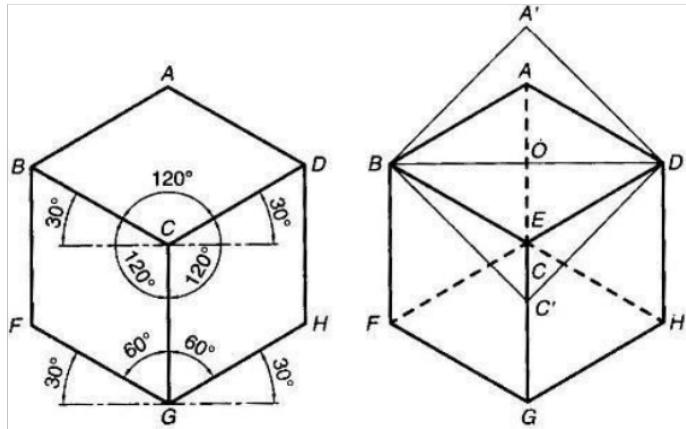
Figure 4.3

Isometric axes: The Three Lines CB, CD, CG meeting at a point C and making an angle of 120^0 with each other are called Isometric axes.

Isometric Lines: The Lines parallel to the Isometric Axis are termed as Isometric lines. Example from above fig. AB, AD, GF, GH, BF, DH are Isometric Lines.

Non-Isometric Lines: The lines which are not parallel to the isometric axes are known as Non-Isometric Lines Example from above fig. BD, AC, CF, BG are Non-Isometric Lines.

Isometric Planes: The planes representing the faces of the cube as well as other planes parallel to these planes are termed as Isometric Planes Example from above fig. ABCD, BCGF, CGHD are Isometric Planes

Isometric Scale: It is the scale which is used to convert the true length in to Isometric Length

Isometric views of planes:

Simple Problems:
Problem:
Draw the isometric view of a square with 40mm side?
Solution:

(a)   (b)   (c)
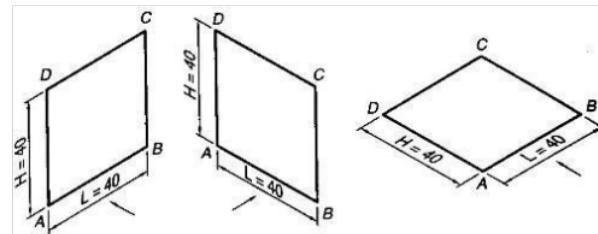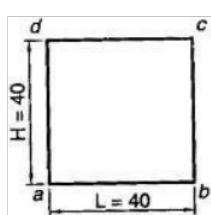
Figure 4.4

Problem:
Draw the isometric view of a Hexagon with 40mm side such that its surface is Parallel to the HP and a side Parallel to the VP?
Solution:

(a)   (b)
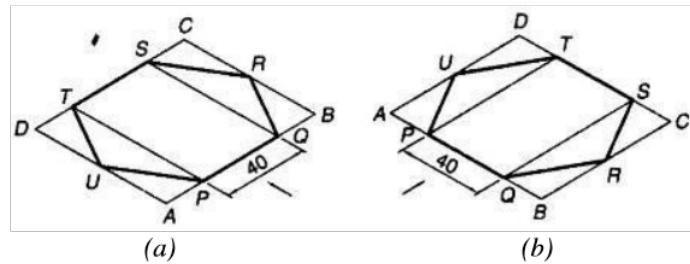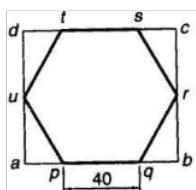
Figure 4.5
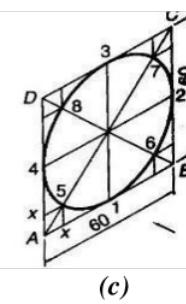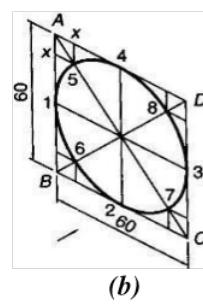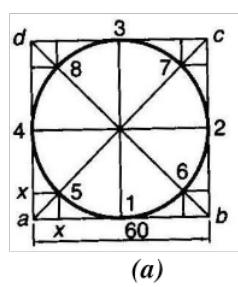
Problem:
Draw the isometric view of a Circle with a 60mm Diameter on all three Principle Planes Using Co-ordinate methods?
Solution:
Construction Procedure:

1. Draw a circle with 60mm Diameter and enclose it in a square abcd.
2. Mark midpoints of the sides 1, 2, 3 and 4, where the square touches the circle tangentially
3. Draw the Diagonals of the square which cut in the circle at points 5, 6, 7 and 8 as shown in fig (a).
4. Draw a Rhombus ABCD to represent Isometric view of a square abcd.
5. Mark points 1, 2, 3 and 4 on it as the midpoint of the sides.
6. Mark points 5, 6, 7 and 8 on it, such that they are at a distance equal to Ax from the side of the square .join points to obtain isometric view as shown in figures(b)(c)(d)

(a)   (b)   (c)

(d)
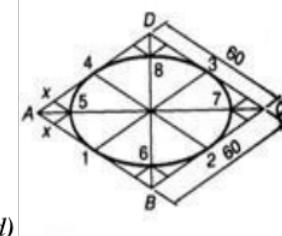
Figure 4.6

Problem:

Draw the isometric view of a Circle lamina with a 60mm Diameter on all three Principle Planes using for center methods?

Solution:

Construction:

1. Draw a Rhombus ABCD of 60mm side to represent isometric view of a square
2. Mark 1,2,3 and 4 as a midpoints of the sides AB,BC,CD and DA respectively join (the ends of the minor diagonals) B to meet points 3 & 4 and D to meet points 1 & 2. Let B4 and D1 intersect at point E and B3 and D2 intersect at a point F. then B,E,D and F are the Four centers for drawing the ellipse
3. With center B and radius B3 draw Arc 3-4. With center D and Radius D1 draw Arc 1-2. With center E and radius E1 draw Arc 1-4. With centre F and radius F2 draw Arc 2-3.
4. These Arcs join in the form of an Ellipse which represents the required isometric as shown in figure (a)(b)(c)

(a)   (b)   (c)
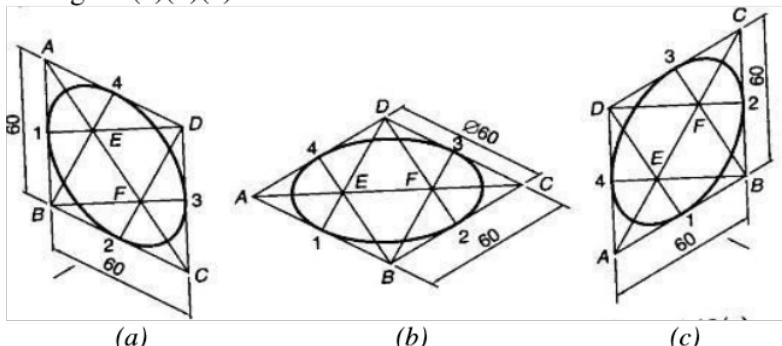
Figure 4.7

Isometric views of solids

Problem:

Draw an isometric view of a square prism having a base with 40mm side and a 60mm long axis, resting on the HP when (a) On its base with axis Perpendicular to the HP (b) On its rectangular faces with axis perpendicular to the VP and (c) on its rectangular face with axis parallel to VP.

Solution:

(a)   (b)   (c)
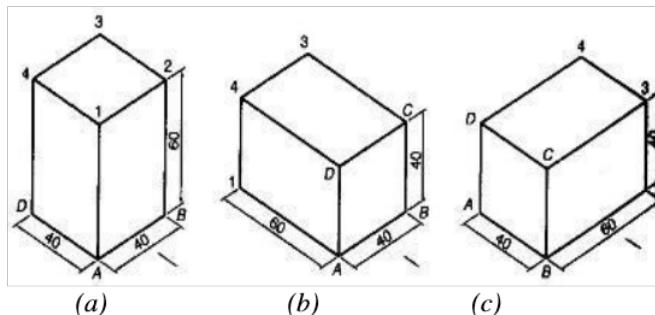
Figure 4.8

ISOMETRIC VIEW OF SOLIDS CONATINING- NON ISOMETRIC LINES

The inclined lines of an object are represented non isometric lines in isometric projections. These are drawn by one of the following methods

1.Box Method:
In this box method, the object is assumed to be enclosed in a rectangular box and both the isometric and non-isometric lines are drawn by locating the corresponding points of contact with the surfaces and edge of the box.
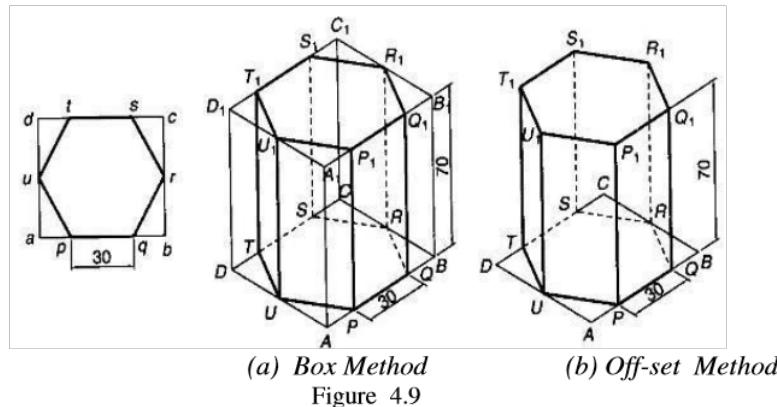
2.Off-Set Method:
In this Off-set Method the lines parallel to isometric axes are drawn from every corner or reference of an end to obtain the corner or the reference point at the other end.

The Box Method is generally convenient for solving most of the problems

Problem:
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?

Solution:

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

Figure 4.9

Problem:
Draw an isometric view of a cylinder, with a 50mm base diameter and a 70mm long axis when
(a) The base is on the HP (b) when one of the generators is on the HP?

Solution:
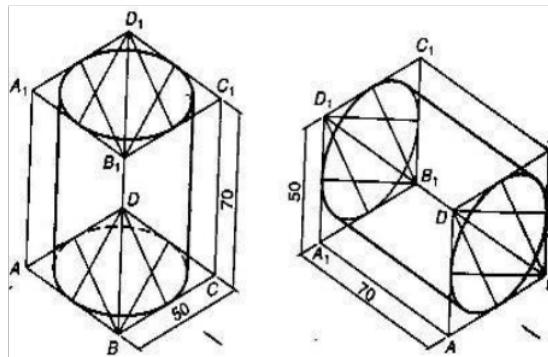
Figure 4.10

Problem:

Draw an isometric view of a pentagonal pyramid having a base , with a 30 mm side and 50mm long axis (a) when the its axis is vertical (b) when the its axis is horizontal?

Solution:
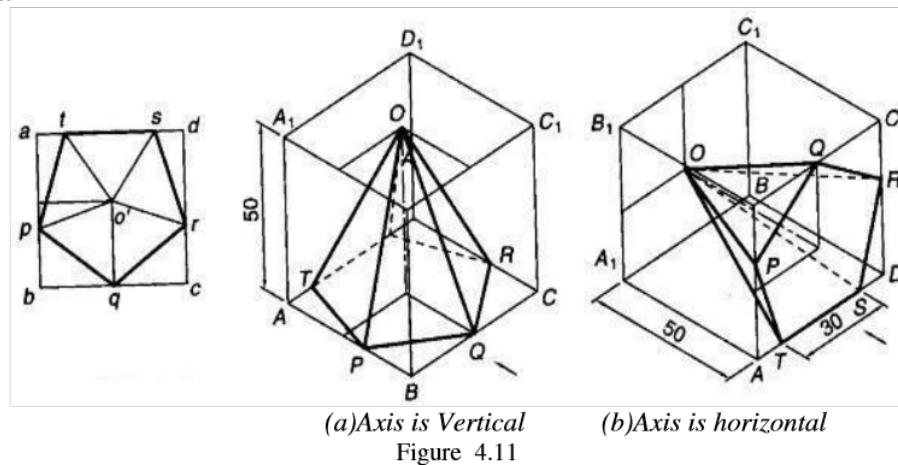
(a)Axis is Vertical   *(b)Axis is horizontal*
Figure 4.11

Problem:

Draw an isometric view of Cone with a base diameter is 50 mm side and 70mm long axis (a) when the base is on the HP (b) when the base is on the VP?

Solution:
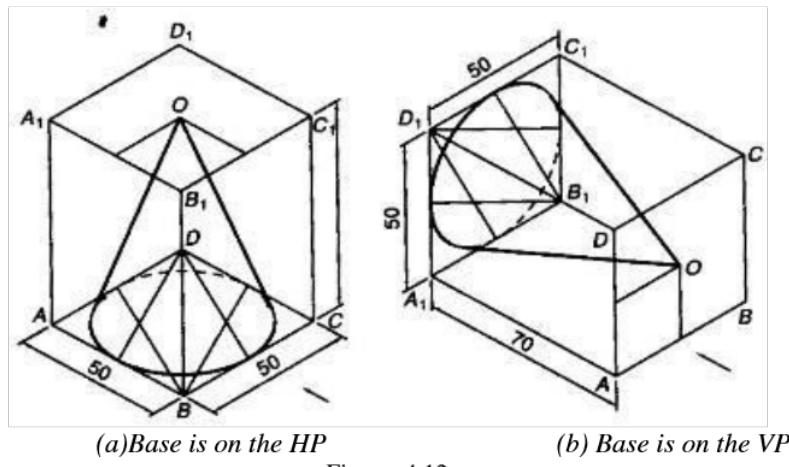
(a)Base is on the HP   *(b) Base is on the VP*
Figure 4.12

ISOMETRIC VIEW OF FRUSTUMS

Problem:

Draw an isometric view of Frustum of Hexagonal Pyramid having 35 mm base side 20 mm top side and 80mm long axis, resting on its base on the HP with an Edge of the base parallel to the VP?
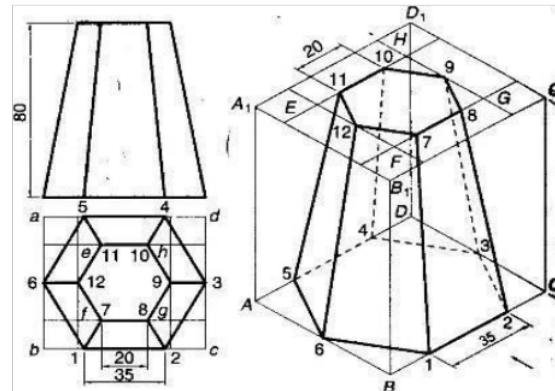
Solution:

Figure 4.13

Problem:

Draw an isometric view of Frustum of Cone with a 60 mm base diameter, 40 mm Top diameter and 70mm long axis, resting on its base on the HP?
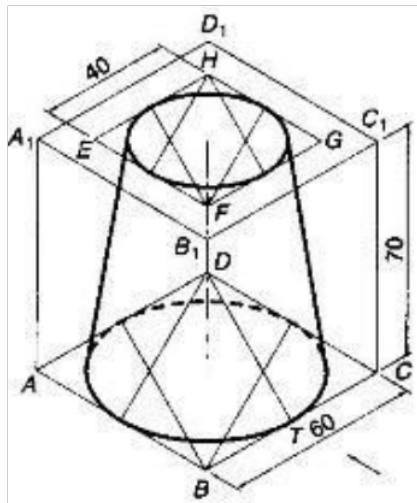
Solution:

Figure 4.14

ISOMETRIC VIEW OF COMPOSITE SOLIDS

Problem:
A Sphere with a 60 mm diameter is resting centrally on the Top of the Square Block with a 70 mm side 20 mm thickness. Draw an isometric view of the arrangement?
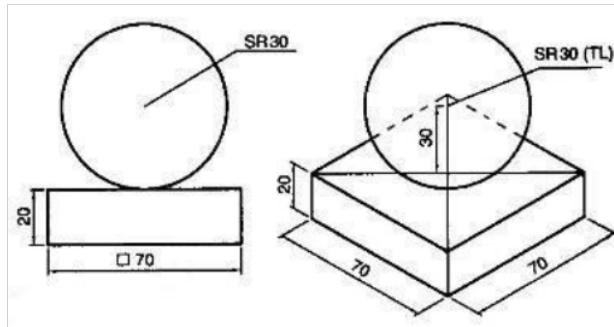
Solution:

Figure 4.15

Problem:
A square pyramid resting centrally over a cylindrical block which is resting centrally on top of the Square block. Draw an isometric projection of the arrangement .consider the pyramid has a base of 25mm side and a 40 mm long axis, the cylinder block has a 50mm base diameter and 20mm thickness and the square block has a70mm base side and 15mm thickness.?

Solution:
Note: Solve this problem by using isometric scale (reduced length)
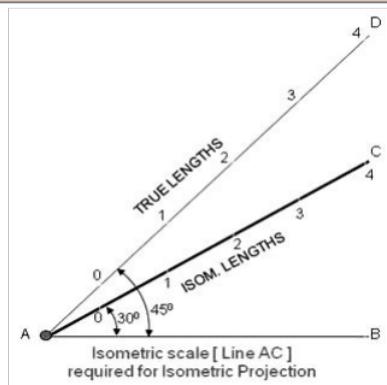
Figure 4.16(a)
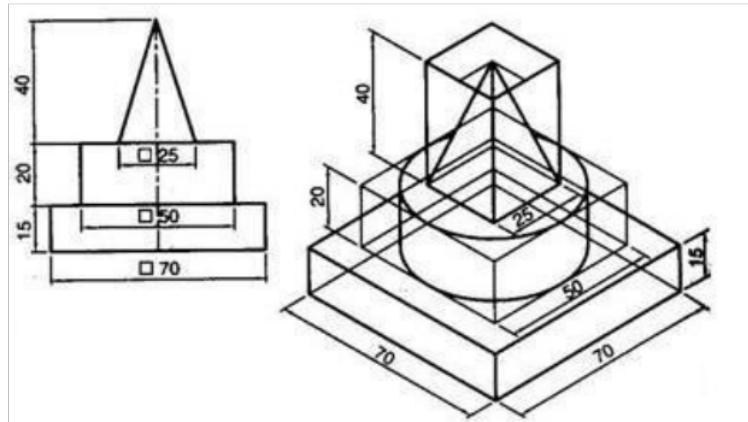
Figure 4.16(b)

Problem:

Draw the isometric view of the given orthographic projection of the object?
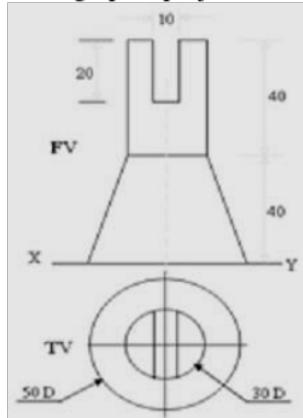
Figure 4.17(a)
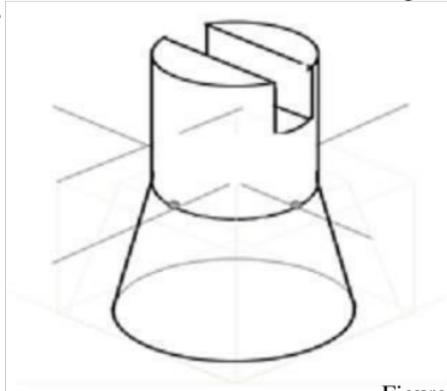
Solution:

Figure 4.17(b)

Problem:
Draw the isometric view of the given orthographic projection of the object?
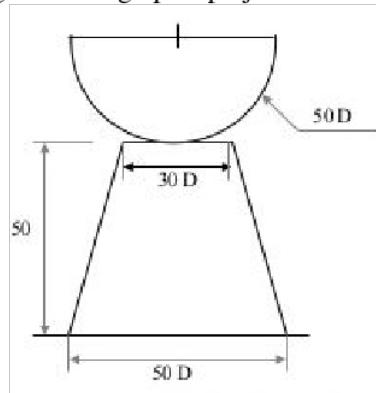
Figure 4.18(a)
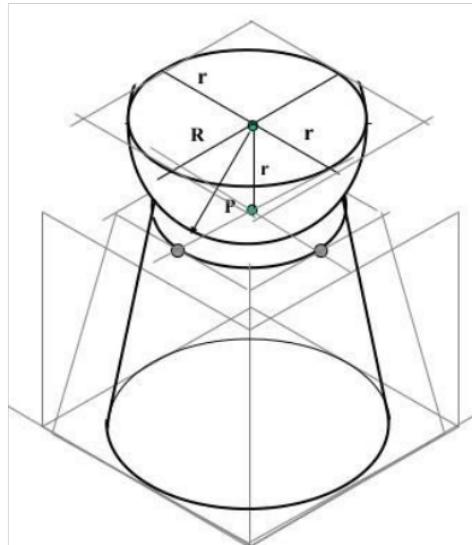
Solution:


Figure 4.18(b)

Problem:
A square pyramid of 40mm base side and 60mm axis is cut by an inclined section plane through the midpoint of axis as shown. Draw isometric view of section of pyramid?
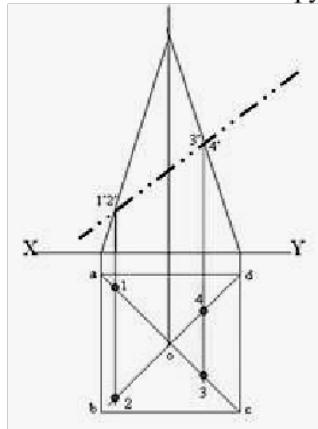
Figure 4.19(a)

Solution:
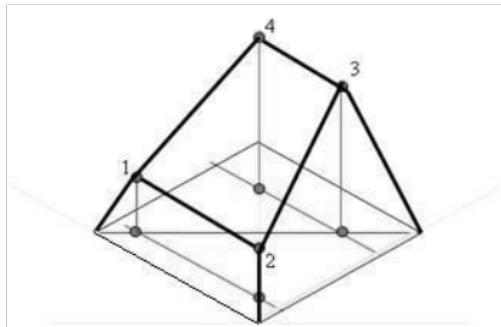
Figure 4.19(b)

Problem:

Draw the isometric view of the given orthographic projection of the object?
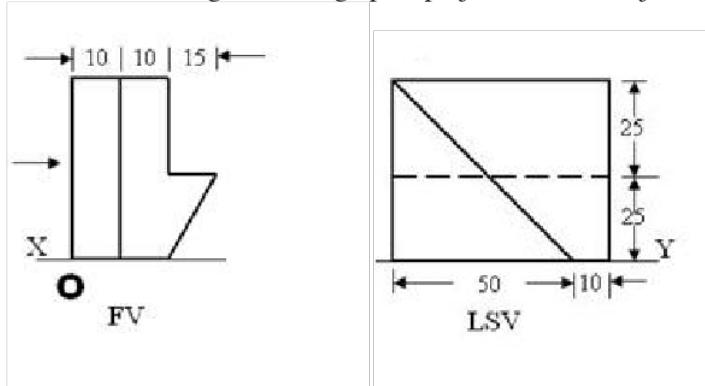
Figure 4.20(a)

Solution:
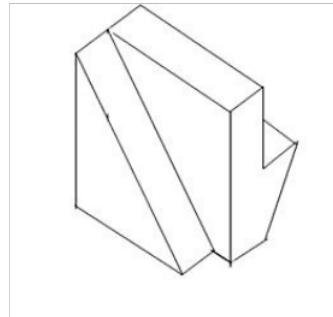
Figure 4.20(b)

Problem:
Draw the isometric view of the given orthographic projection of the object?
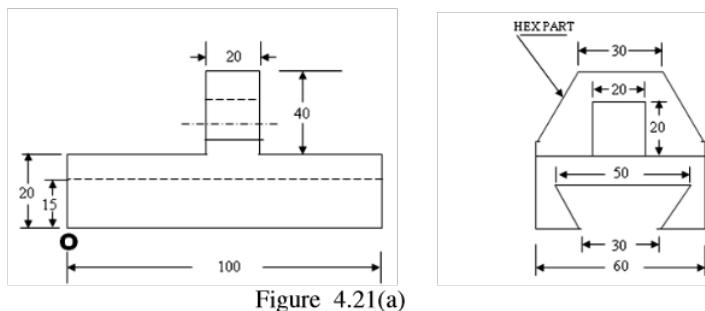
Figure 4.21(a)
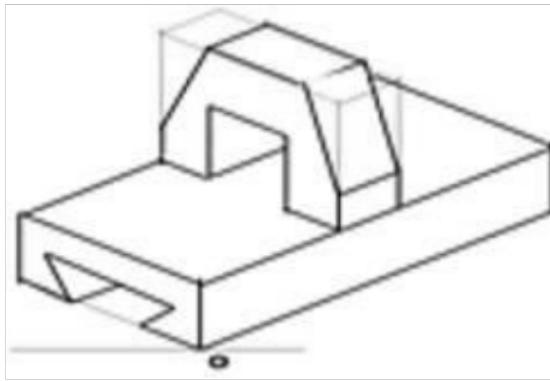
Solution:

Figure 4.21(b)

Problem:
Draw the isometric view of the given orthographic projection of the object?
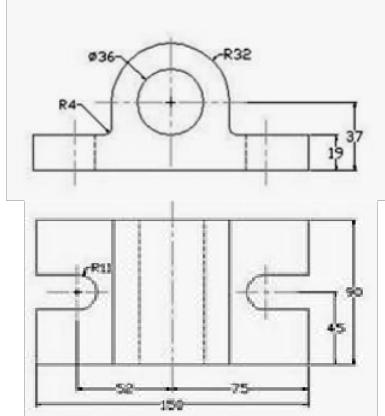
Figure 4.22(a)
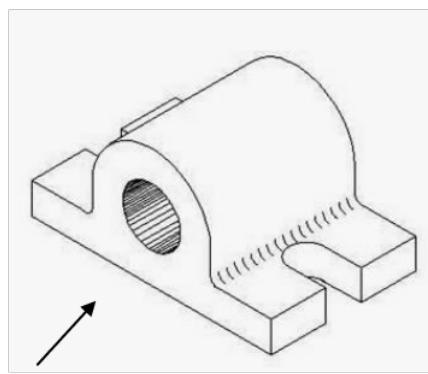
Solution:

Figure 4.22(b)

Problem:

Draw the isometric view of the given orthographic projection of the object?
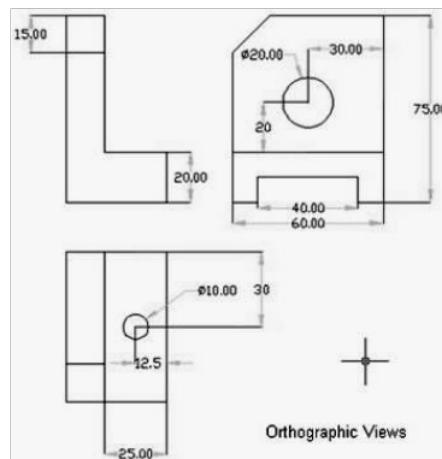
Figure 4.23(a)
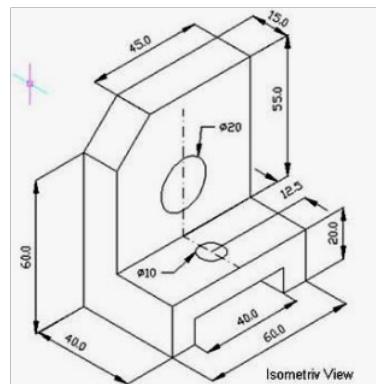
Solution:

Figure 4.23(b)

Problem:

Draw the isometric view of the given orthographic projection of the object?
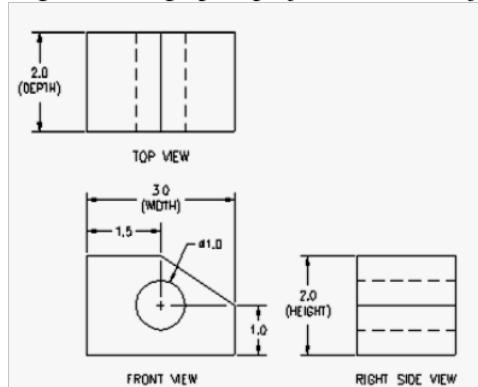
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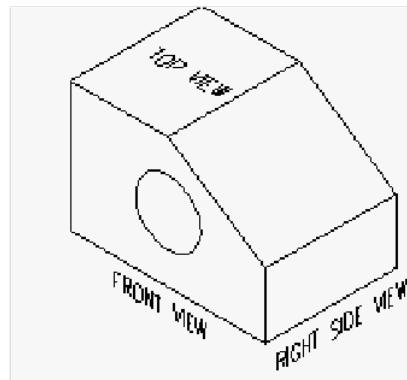
Solution:

Figure 4.24(b)

Problem:

Draw the isometric view of the given orthographic projection of the object?
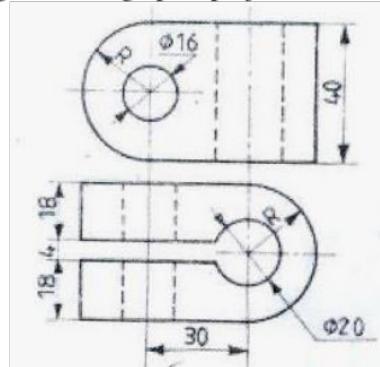
Figure 4.25(a)
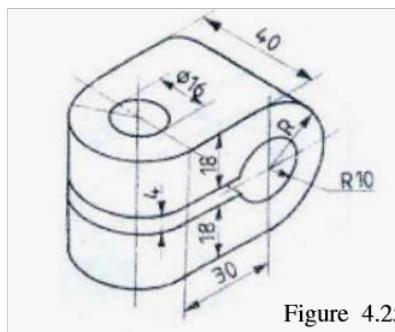
Solution:

Figure 4.25(b)

Problem:

Draw the isometric view of the given orthographic projection of the object?
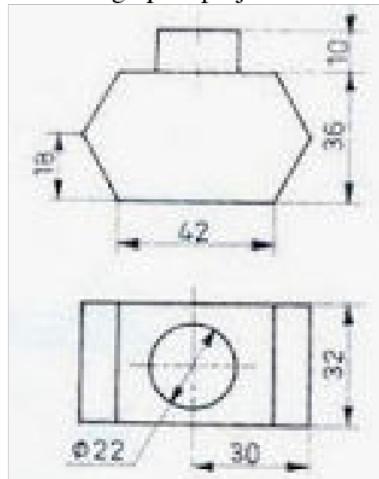
Figure 4.26(a)
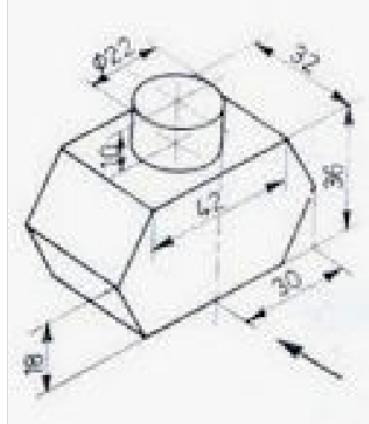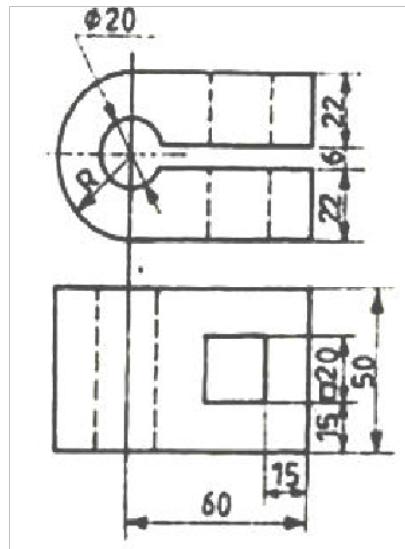
Solution:
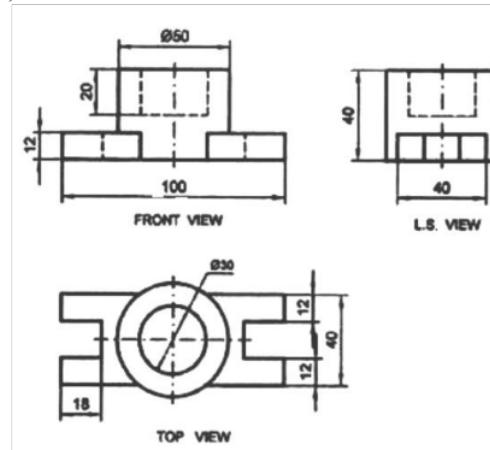
Figure 4.26(b)

Previous Paper Questions:

1. A cylindrical block of base,60 mm diameter and height 90 mm, standing on the HP, with its axis perpendicular to the HP. Draw its isometric view.

2. Draw an isometric view of a hexagonal prism having a base with 25mm side and 65 mm long axis which is lying on its face in the HP, with axis parallel to both HP and VP.

3. Two views of a casting are shown in figure 1. Draw the isometric projection of the casting (all dimensions are in mm)

Figure 1

4. Three views of a machine part are shown in figure 2. Draw the isometric view of the part (All dimensions are in mm).

Figure 2

5. Draw the isometric view of a cylinder of 60 mm height and diameter 44 mm, lying on one of its generators on HP with the axis perpendicular to VP. Select the origin of the isometric axes suitable to get the front view on the right isometric plane.

6. The frustum of a sphere with a 80 mm diameter and frustum circle with a 50 mm diameter is used as a paper weight. Draw its isometric projection.

UNIT-5
ORTHOGRAPHIC PROJECTION

Introduction

Projection: Projection is defined as an Image or drawing of the object made on a plane. The lines form the object to the Plane are called projectors.
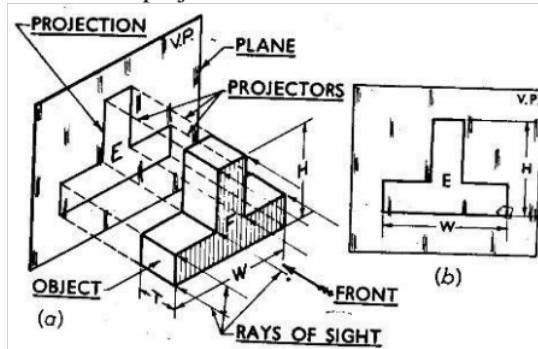
Figure 5.1

Methods of Projections: In Engineering drawing the following four methods of Projection are commonly used they are
(1) Orthographic Projection
(2) Isometric projection
(3) Oblique projection
(4) Perspective Projection

In orthographic projection an object is represented by two are three views on the mutual perpendicular projection planes each projection view represents two dimensions of an object.
In iso, oblique and perspective projections represents the object by a pictorial view as eyes see it. In these methods of projects in three dimensional object is represented on a projection plane by one view only.

Orthographic Projection
When the Projectors are parallel to each other and also perpendicular to the plane the projection is called orthographic Projection

Example: Orthographic projection of a car shown in below figure.
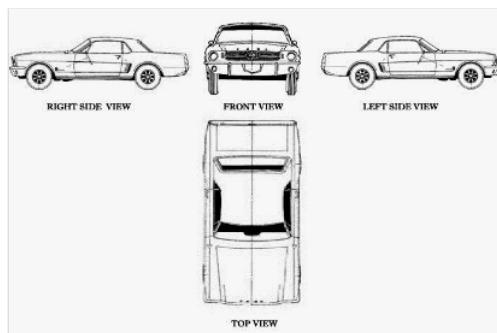
Figure 5.2

We can represent in orthographic projection two to three views enough as shown in below figures

Figure 5.3
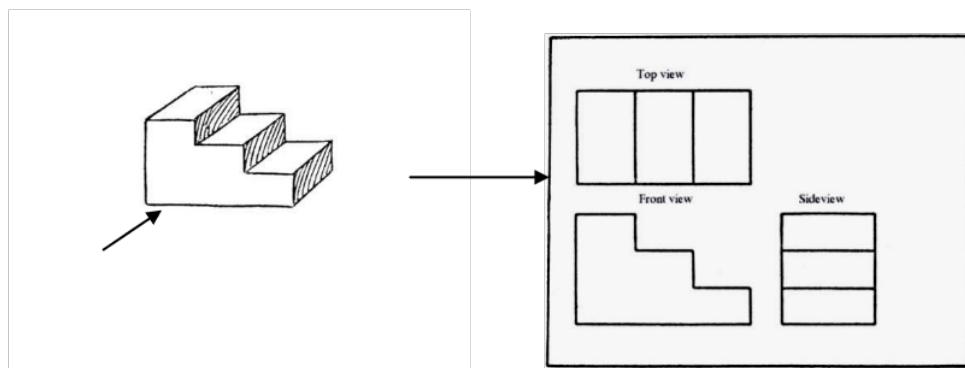
Figure 5.4

Orthographic projection of given object

Orthographic Projection is a way of drawing an 3D object from different directions. Usually a front, side and plan view is drawn so that a person looking at the drawing can see all the important sides. Orthographic drawings are useful especially when a design has been developed to a stage whereby it is almost ready to manufacture.

Plane of projection: Two planes employed for the purpose of orthographic projections are called reference planes or planes of projection. they are intersect each other at right angle to each other the vertical plane of projection is usually denoted by the letters **VP** and the other Plane is horizontal plane of Projection is denoted by **HP** . The line in which they intersect is termed as the reference line and is denoted by the letters **xy.**

Four quadrants:
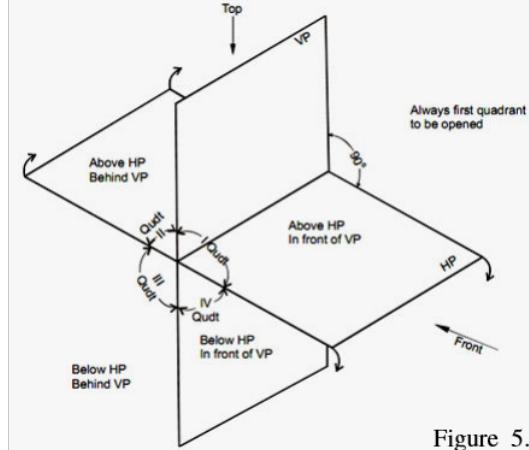
Figure 5.5

The intersection of mutual perpendicular Planes i.e Vertical Plane and Horizontal Plane Form Four quadrants as shown above figure 5.5. Here planes to be assumed transparent here the object may be situated any one of four quadrants. The projections are obtained by drawing perpendiculars from the object to the planes, i.e by looking from the Front and Top. It should be remembered that the first and third quadrants always opened out while rotating the planes. The position of views with respect to the reference line will change according to quadrant in which object may be situated as shown in below figures.

First angle Projection:
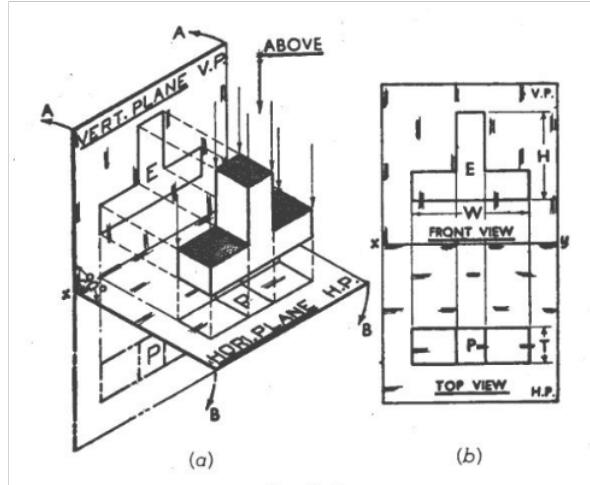
Figure 5.6

We have assumed the object to be situated in front of the VP and above the HP i.e First quadrant and then projected it on these planes, the method of projection is known as **First angle projection method.**

Here object lies between observer and plane of projection. In this method when the views are drawn in their relative positions the Top view comes below the front view.

Third angle Projection:
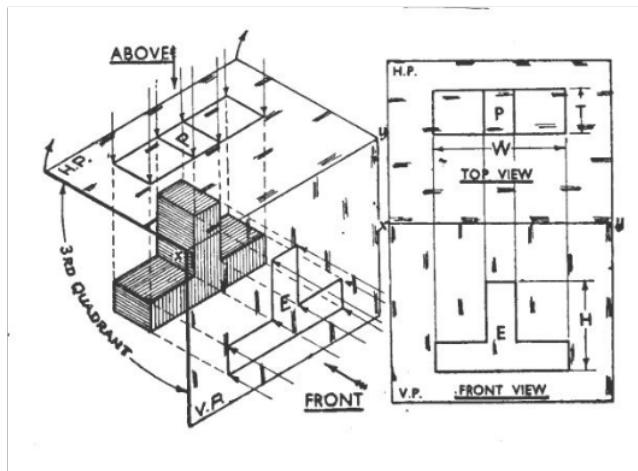
Figure 5.7

Here the object is assumed to be situated in third quadrant, here Plane of projection assumed to be transparent. It lies between Object and the observer. In this method when the views are drawn in their relative positions the Top view comes below the front view.

Reference Line:

While representing Projections it can be seen that while considering the front view which is seen from front the HP coincides with the line xy in their words xy represents HP.

Similarly while considering Top view which view obtained by looking from above, the same line xy represents the VP hence, when the projections are drawn in correct relationship with each other xy represents both the HP and VP this is called as Reference line.
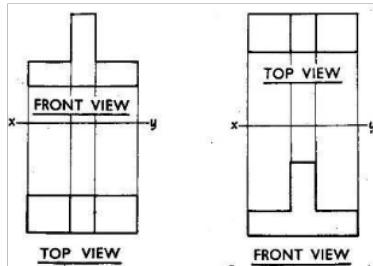

Figure 5.8

Note: There are two ways of drawing in orthographic - First Angle and Third Angle. They differ only in the position of the plan, front and side views.

Problems:

Draw the front view, Top view and Side view of the given figure?
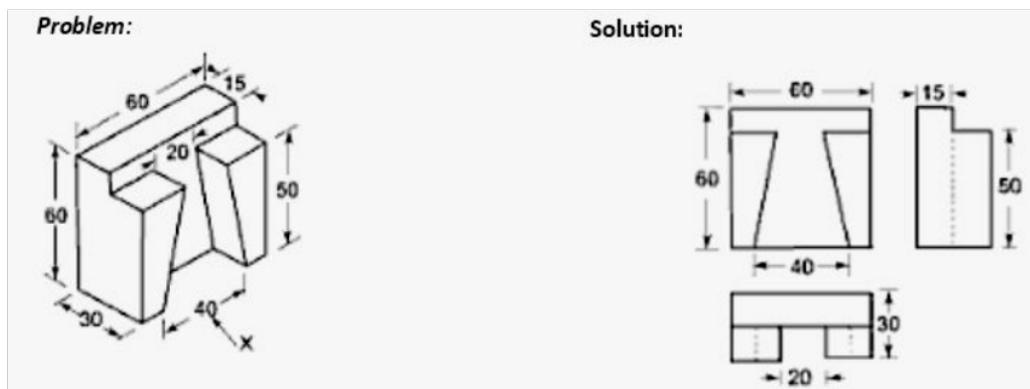
Figure 5.9
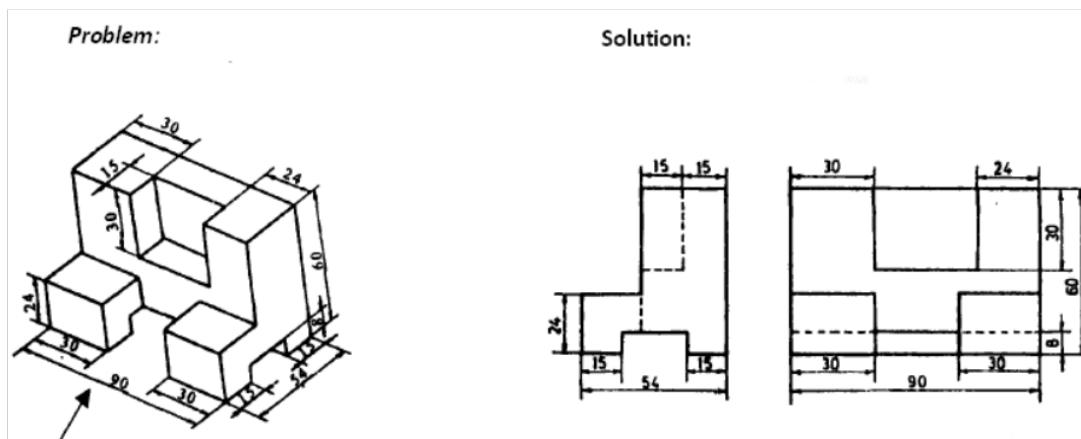
Figure 5.10
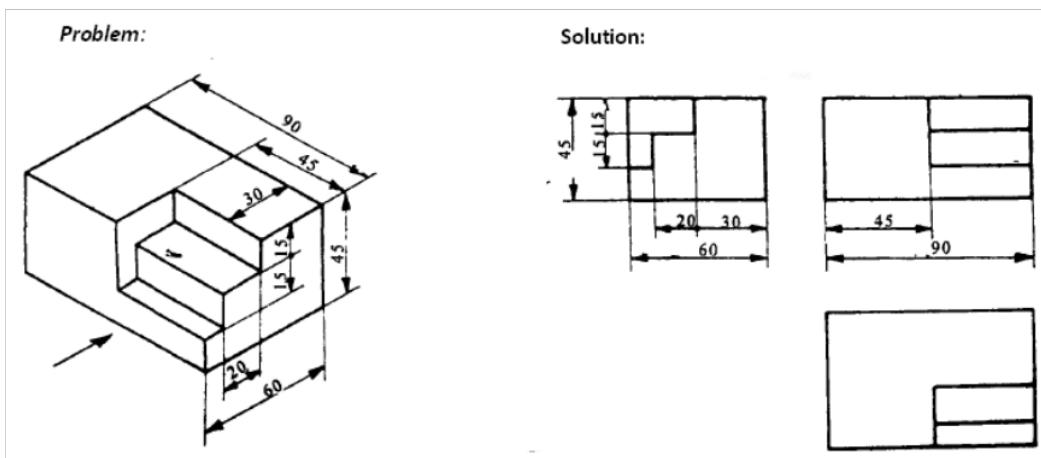
Figure 5.11

Problem   Solution
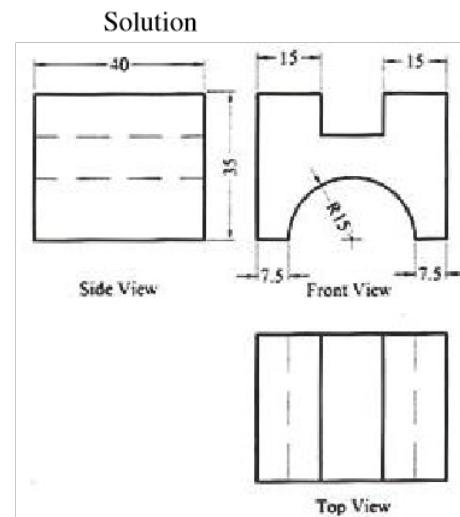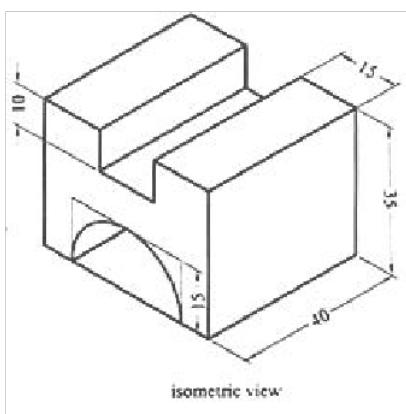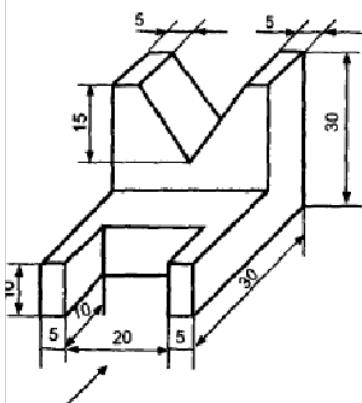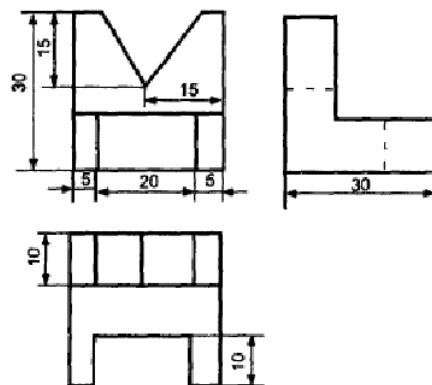
Figure 5.12
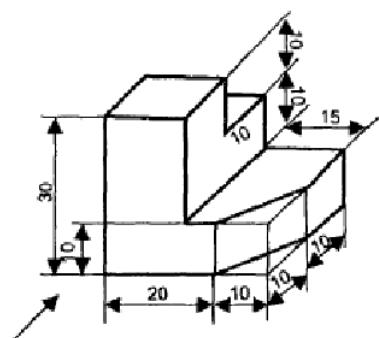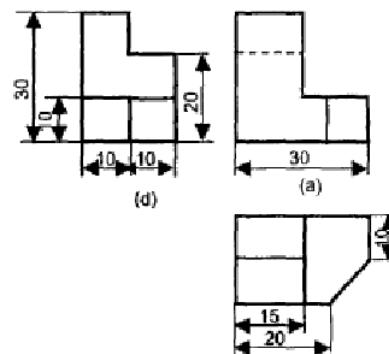
Figure 5.13

Problem:

Solution:


Figure 5.14
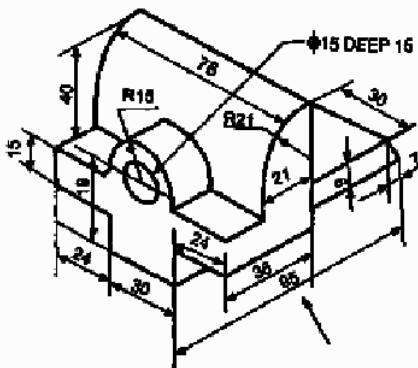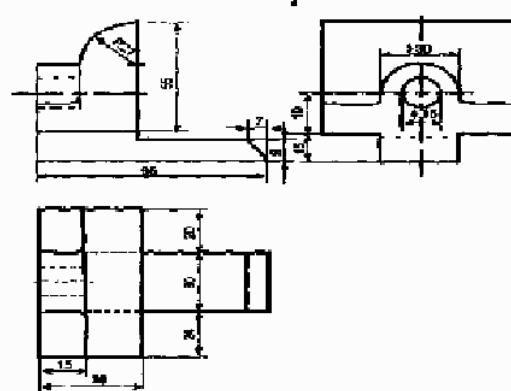
Problem:

Solution:

Figure 5.15
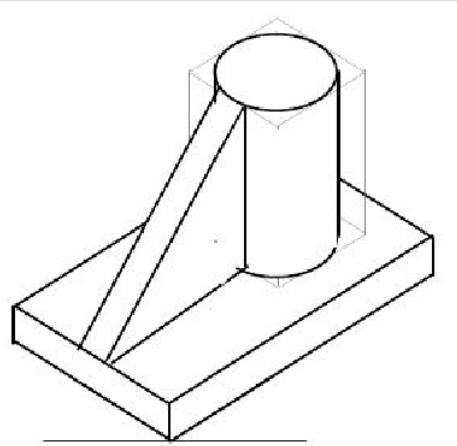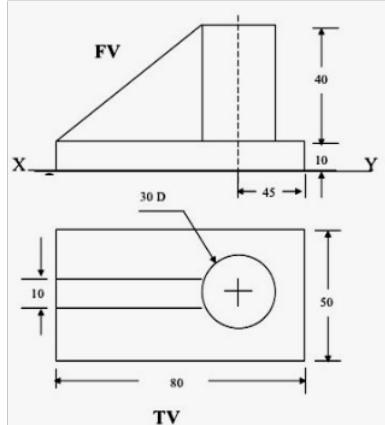
Problem:

Solution:

Figure 5.16
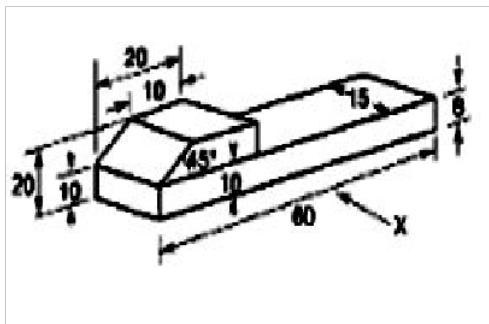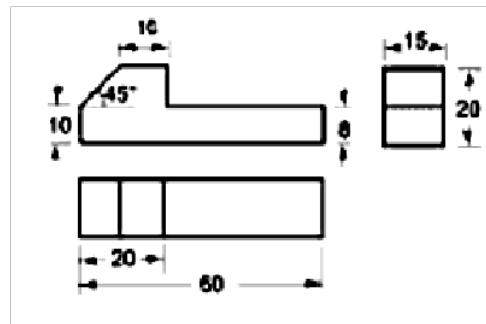
*Problem:*   *Solution:*


Figure 5.17
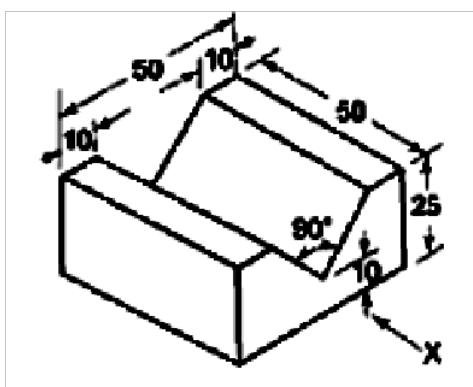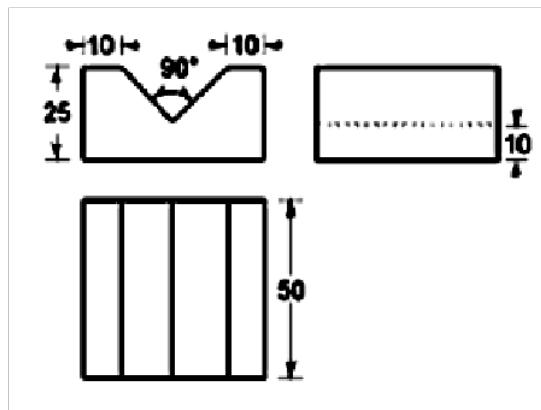
Problem: *Solution:*

Figure 5.18
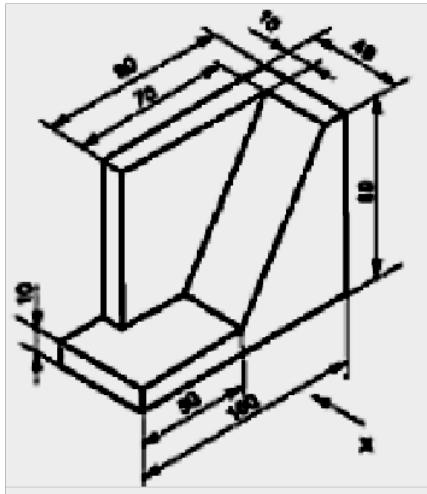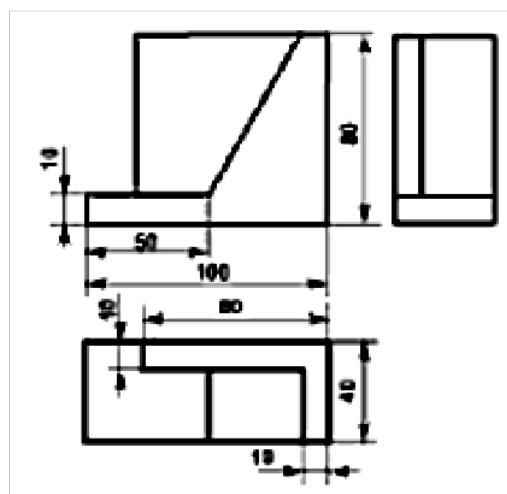
Problem: *Solution*

Figure 5.19
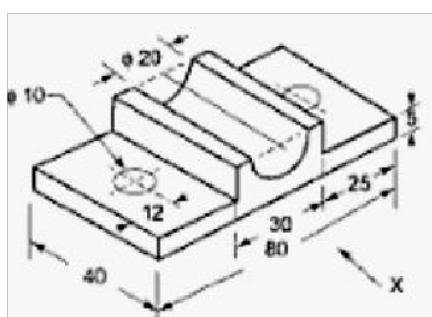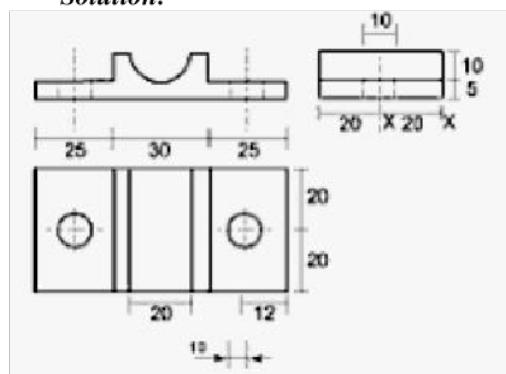
Problem: *Solution:*


Figure 5.20
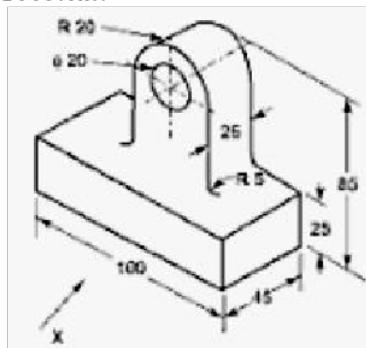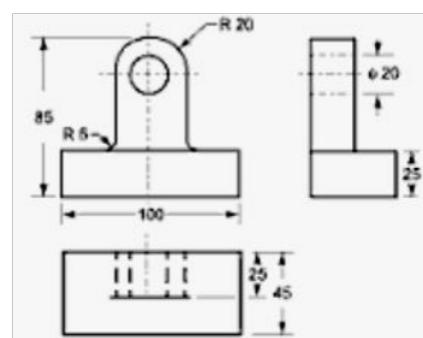
Problem: *Solution:*

Figure5.21
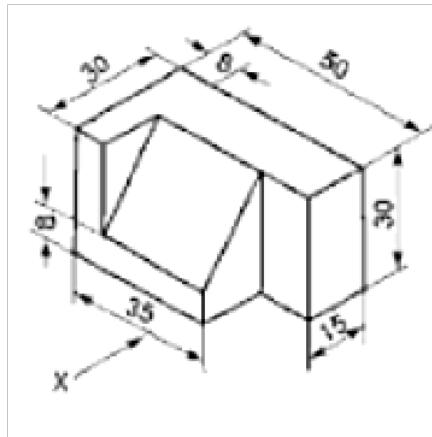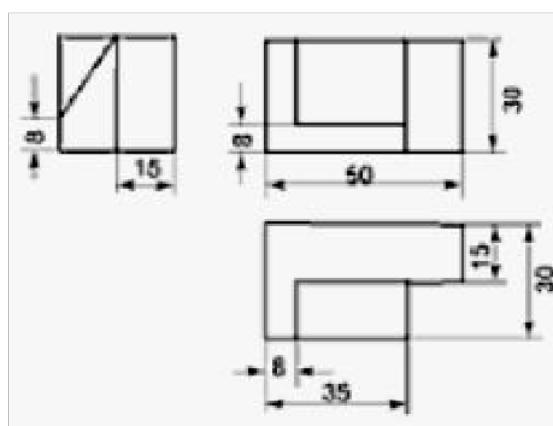
Problem: *Solution:*

Figure5.22
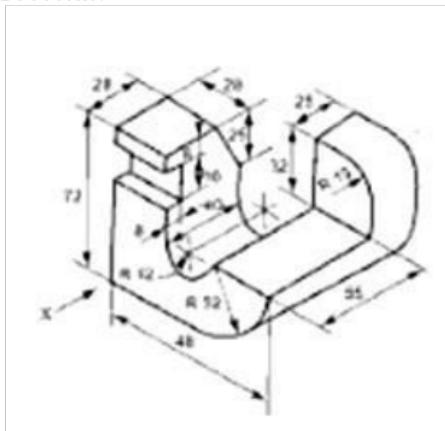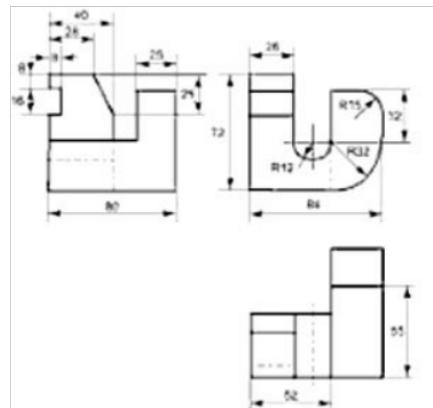
Problem: *Solution:*

Figure5.23
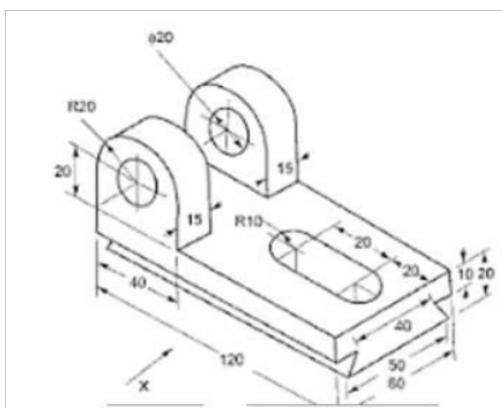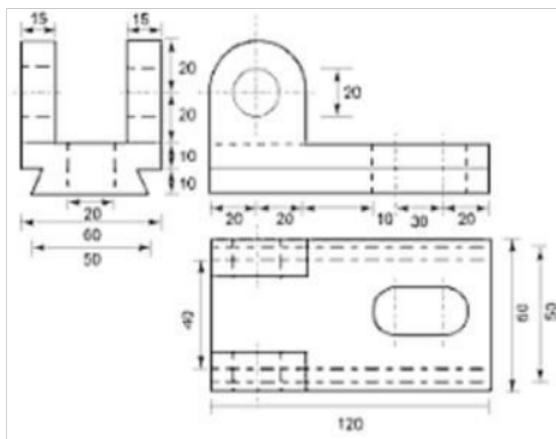
Problem: *Solution:*

Figure5.24
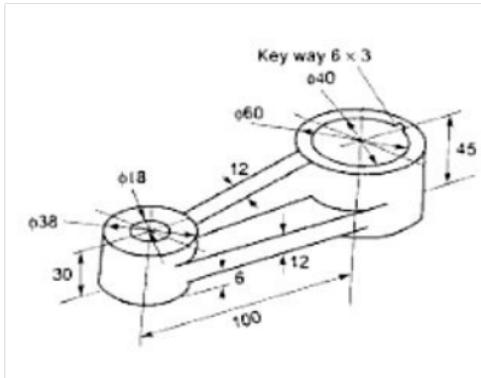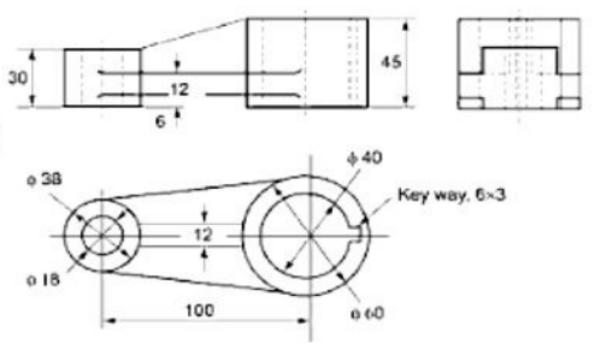
Problem: *Solution:*

Figure5.25
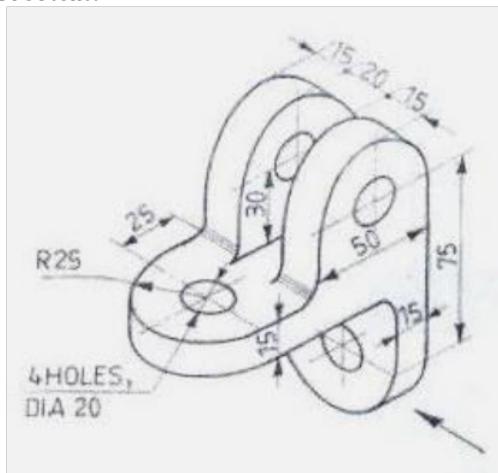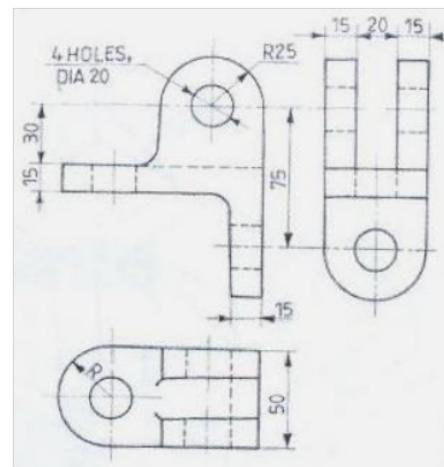
*Problem:*   *Solution:*

Figure 5.26
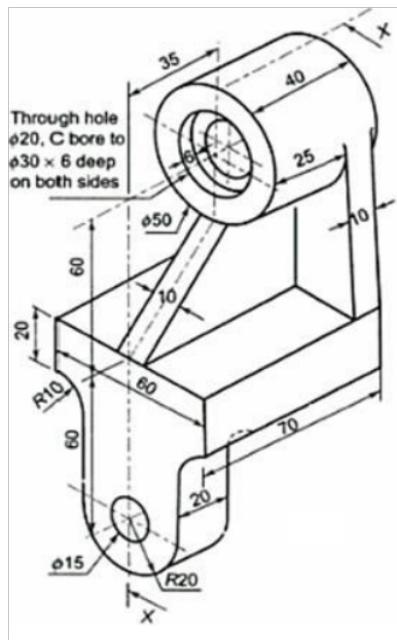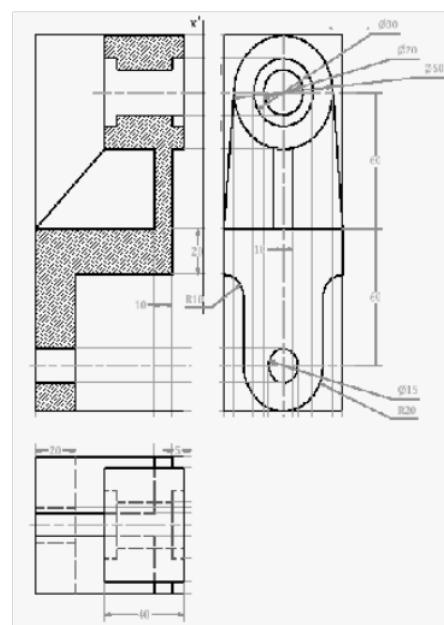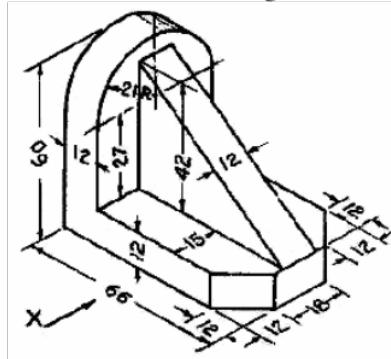
Problem: *Solution:*
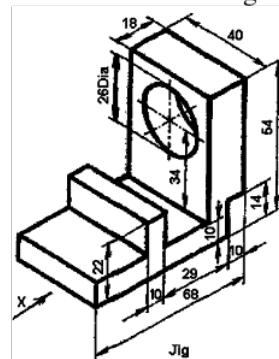
Figure 5.27

Previous Paper Questions:
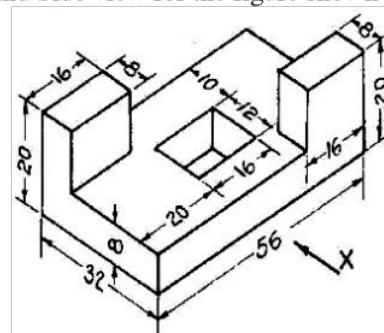
1. Draw Front View, Top view and Side view for the figure shown below. All dimensions are in mm.
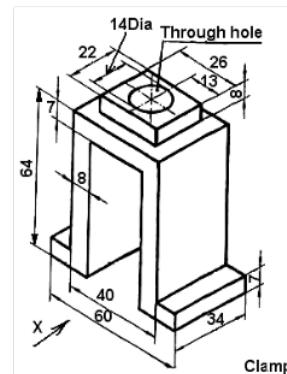
2. Draw the Front view, Top view and Side view for the figure shown below. All dimensions are in mm.
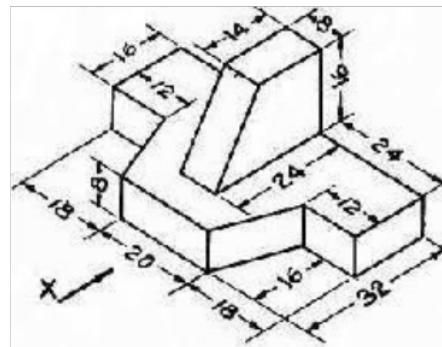
3. Draw the Front view, Top view and Side view for the figure shown below. All dimensions are in mm.
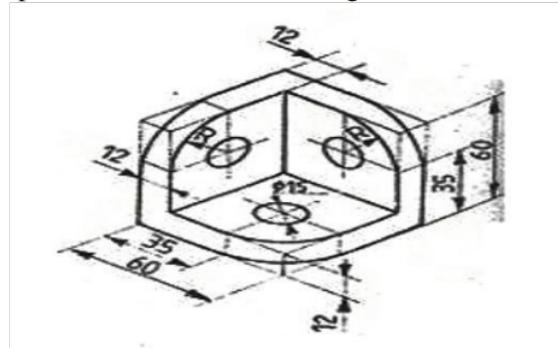
4. Draw the front view, top view, & side view for the figure shown below. All dimensions are in mm.
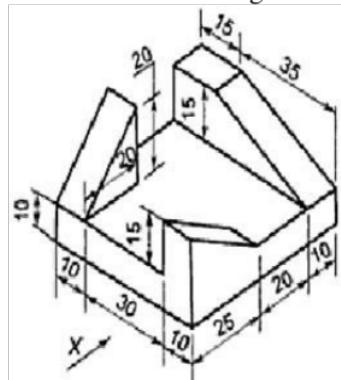
5. Draw the front view, top view and side view of the figure shown below. All dimensions are in mm
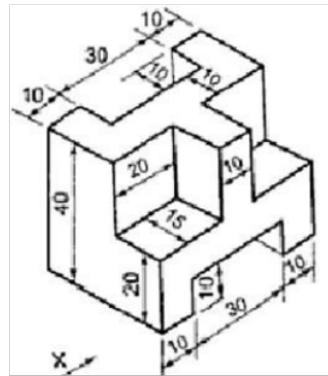
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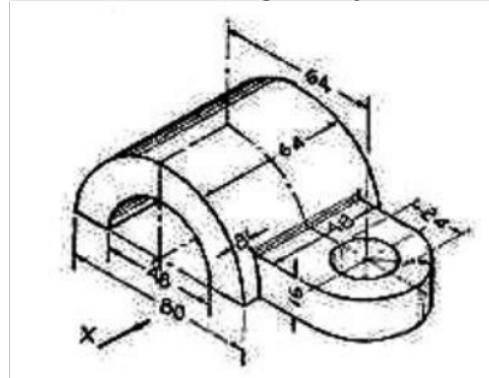
7. Draw the front view, top view and side view of the figure shown below. All dimensions are in mm
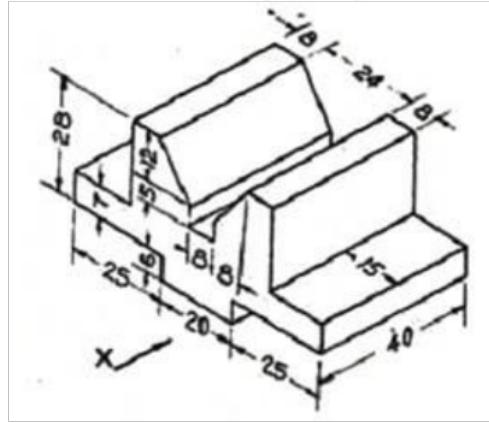
8. Draw the front view, top view and side view of given object below. All dimensions are in mm
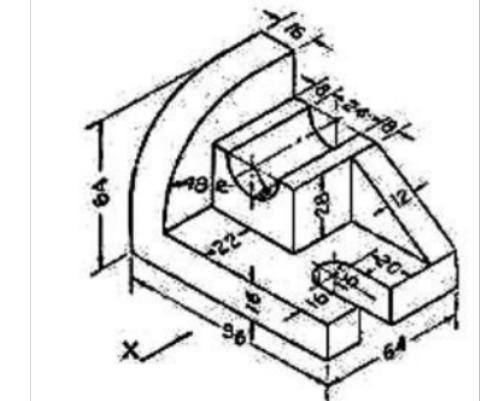
9. Draw the front view, top view and side view of given object below. All dimensions are in mm
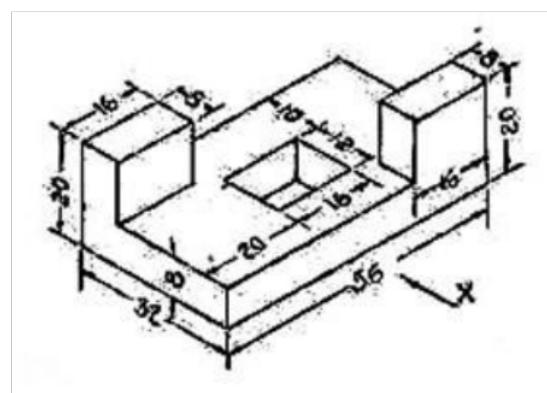
10. Draw the front view, top view and side view of given object below. All dimensions are in mm
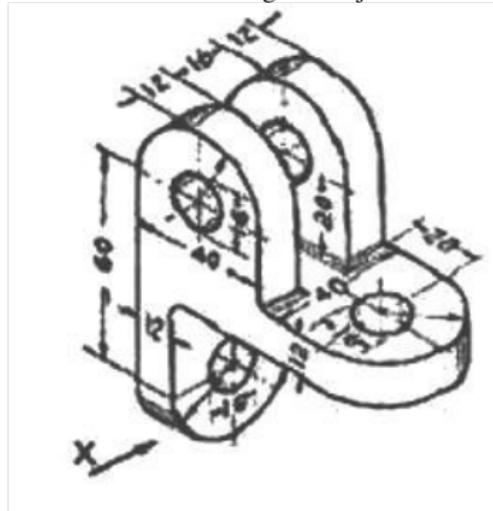
11. Draw the front view, top view and side view of given object below. All dimensions are in mm
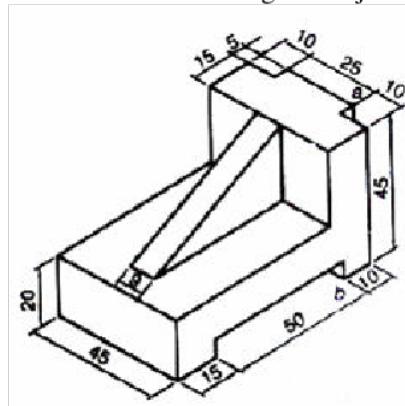
12. Draw the front view, top view and side view of given object below. All dimensions are in mm
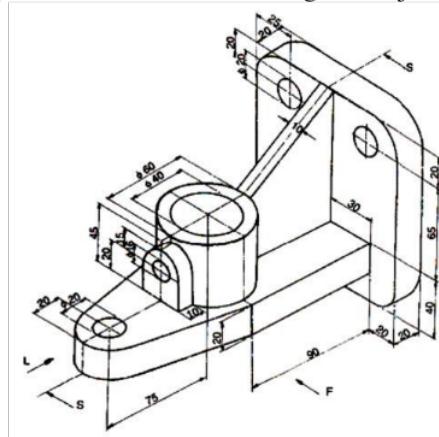
13. Draw the front view, top view and side view of given object below. All dimensions are in mm

14. Draw the front view, top view and side view of the given object below. All dimensions are in mm

15. Draw the front view, top view and side view of the given object below. All dimensions are in mm