Unit 1:

1.1 INTRODUCTION & DEMONSTRATION

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

1.2 LIST OF INSTRUMENTS USED IN DRAWING:-

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

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

1.3 TYPES OF LINES,LETTERING & DIMENSIONING

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

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

Single Stroke Letters

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

Single-stroke letters are of two types:

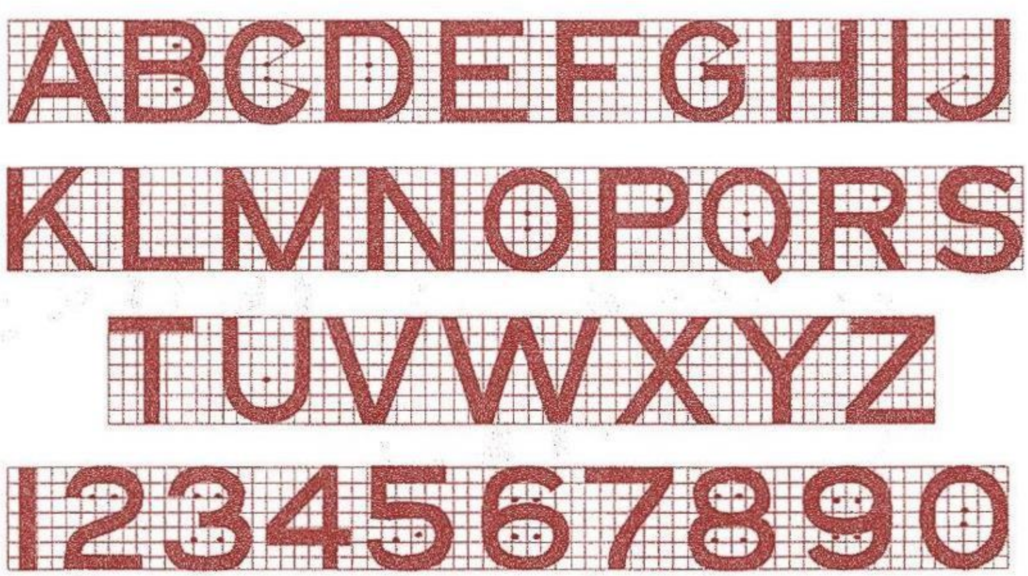
i. Vertical

ii. Inclined. (Inclined letters lean to the right, the slope being 75° with the horizontal) According to the height of letters, they are classified as:

i. Lettering 'A'

ii. Lettering 'B'

S. No.	*Representation*	*Description*
01		Continuous line
02		Dashed line
03		Dashed space line
04		Long dashed dotted line
05		Long dashed double-dotted line
06		Long dashed triplicate-dotted line
07		Dotted line
08		Long dashed short dashed line
09		Long dashed double-short dashed line
10		Dashed dotted line
11		Double-dashed dotted line
12		Dashed double-dotted line
13		Double-dashed double-dotted line
14		Dashed triplicate-dotted line
15		Double-dashed triplicate-dotted line



1.5 Dimensioning

Dimensioning is the process of specifying part‟s information by use of lines, numbers, symbolsand notes.

The general principle of dimensioning :

- As far as possible, it should be placed outside the view.
- It should be taken from a visible line rather than hidden lines.
- Dimensioning of a centre line should be avoided except when the centre line passes through thecentre of a-holes.
- The dimension should be placed on the view or section which is most clear to the correspondingfeatures.
- Each dimension should be dimensioned once on a drawing.
- Each drawing should have the same dimensional unit.
- More than one dimension should not be used for features of the same parts.

Elements of Dimensioning

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

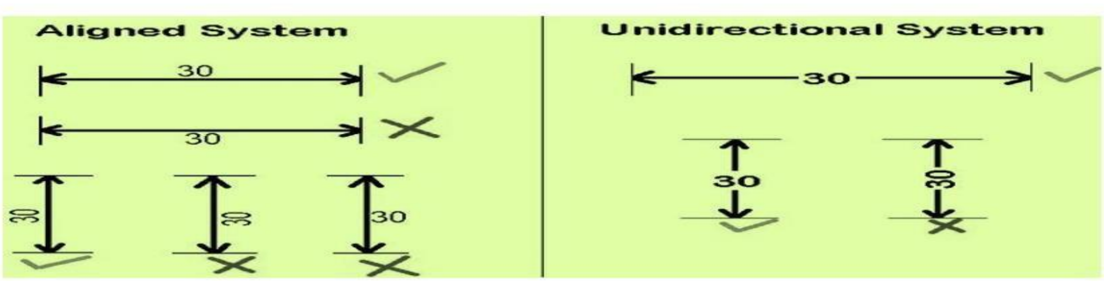
Types of Dimensioning systems:

Aligned System :

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

Unidirectional System:

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



1.6 SCALE:

Introduction

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

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

Purpose of Scale

Scales are used for the following purposes :

1. To prepare a drawing on a reduced scale so that large object can be accommodated on thelimited size of drawing sheet.

   e.g. building, machine parts etc.
2. To prepare the drawing of a very small objects.

   e.g. parts of wrist watches, measuring instruments etc. on enlarged scale in order to give better understanding and to study the details of the minor parts of the objects.
3. To measure linear measurements of the object under measurement directly without involving anycalculations.
4. To measure and set off dimensions as per scales decided upon or given before starting thedrawing.

Types of scale :

Reducing Scale :

It is the scale in which the actual measurements of objects are reduced and represented onthe drawing sheet. Generally the drawings are very big objects like buildings, machine parts; town plans etc areprepared in reduced scale. The standard proportions are : 1:2, 1:5, 1:10, 1:20, 1:50, 1:100, 1:200, 1:500, 1:1000, 1:2000, 1:5000, 1:10000

for this scale, RF < 1

Example-If the actual size of the object is 100cm then using R.F. of 1:10, the size of theobject would be 100 x (1/10)= 10cm in drawing.

Full Size Scale :

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

Example- If the actual size of the object is 150cm then using R.F. of 1:1, the size of the object would be 150 x (1/1)= 150 cm in drawing.

Enlarging Scale :

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

Generally the drawings of very small objects like watches, electronic devices, precision instruments etc. are prepared in enlarging scale. The standard enlarging scales are : 50:1, 20:1, 10:1, 5:1, 2:1 for this scale, R.F.>1

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

Representitive Factor

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

$$RF = \frac{Length\ of\ the\ element\ in\ the\ drawing}{Actual\ length\ of\ the\ element}$$

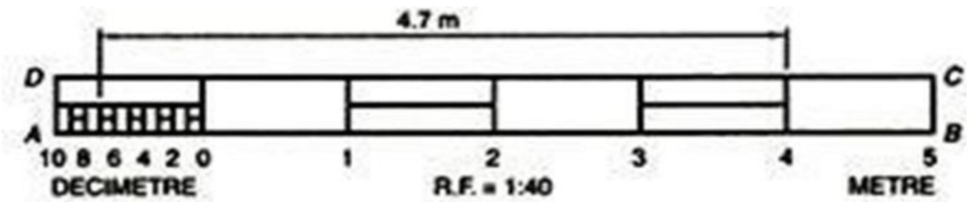
Metric system for linear measurement	*British system for linear measurement*
1 kilometre (km) = 10 hectometres	1 league = 3 miles
1 hectometre (Hm) = 10 decametres	1 mile (mi) = 8 furlongs
1 decametre (Dm or dam) = 10 metres	1 furlong (fur) = 10 chains
1 metre (m) = 10 decimetres	1 chain (ch) = 22 yards
1 decimetre (dm) = 10 centimetres	1 yard (yd) = 3 feet
1 centimetre (cm) = 10 millimetres (mm)	1 foot (ft) = 12 inches
	1 inch (in) = 8 eighth

The following linear and area conversions is also useful in construction of scales.

Linear conversion	1 mile = 1.609 km
	1 inches = 25.4 mm
Area conversion	1 are (a) = 100 m^2
	1 hectare (ha) = 100 ares = 10000 m^2
	1 square mile = 640 acres
	1 acre (ac) = 10 square chain = 4840 square yards

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.

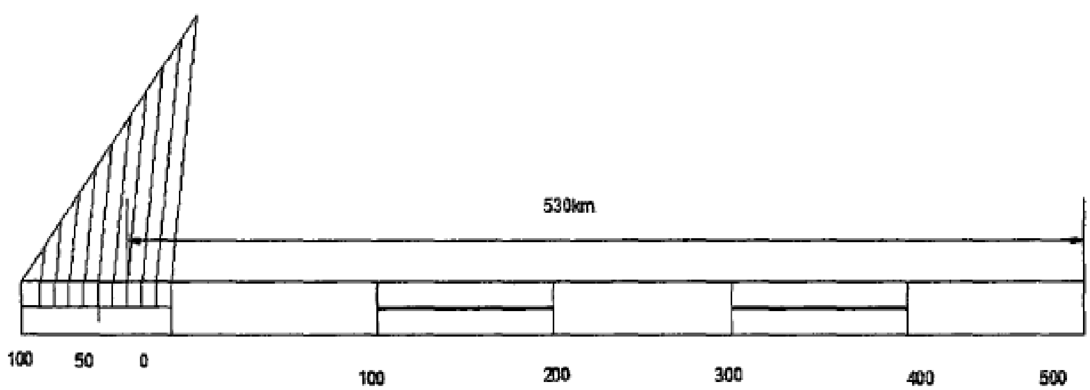


1. Given (a) R.F. = 1/40, (b) Maximum = 6 m and (c) Least count = 1 dm.
2. Calculate length of scale

   L_s = R.F. × 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=1/5×106



R.F=1/5×10^6

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

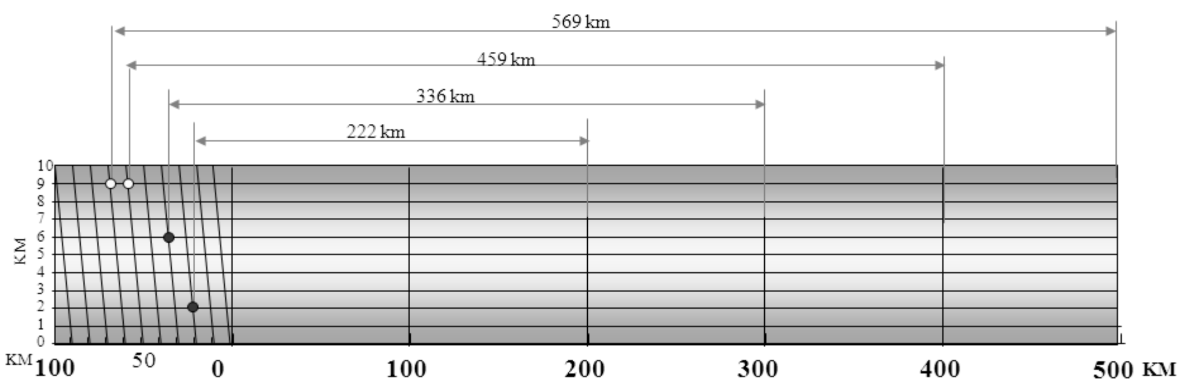
2’ – 2 = 0.2 XY

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

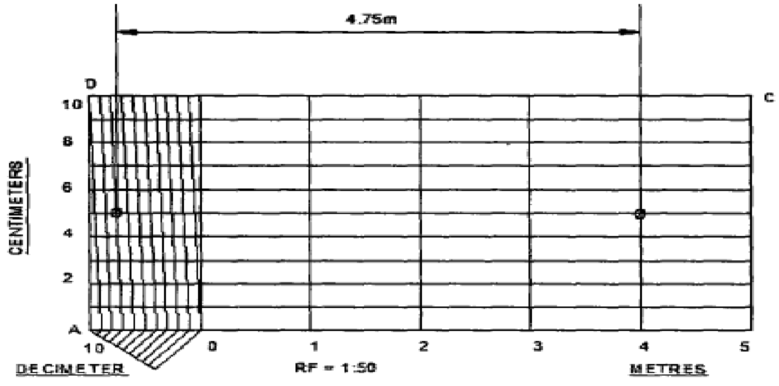
RF = 5 cm / 200 km = 1 / 40, 00, 000

Length of scale = 1 / 40, 00, 000 X 600 X 105 = 15 cm



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

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.



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 α = 90° with the axis, the section obtained is a circle.

b) ELLIPSE:

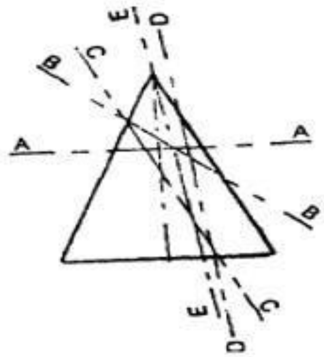
When a cone is cut by a section plane B-B at an angle, α more than half of the apex angle i.e., θ and less than 90°, the curve of the section is an ellipse. Its size depends on the angle α and the distance of the section plane from the apex of the cone.

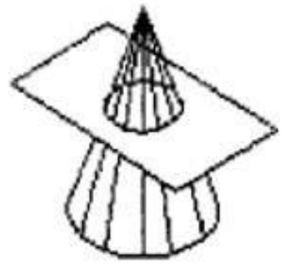
c) PARABOLA:

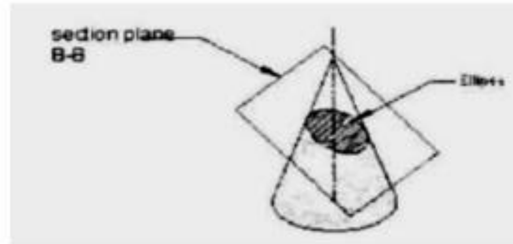
If the angle α is equal to θ i.e., when the section plane C-C is parallel to the slant side of the cone the curve at the section is a parabola. This is not a closed figure like circle or ellipse. The size of the parabola depends upon the distance of the section plane from the slant side of the cone.

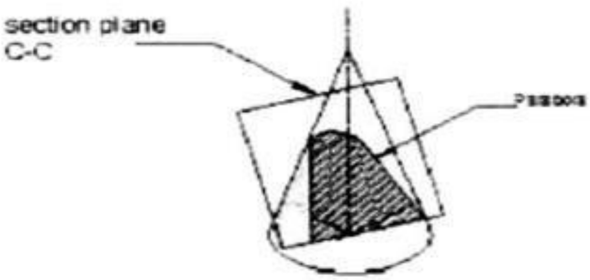
d) HYPERBOLA:

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 α = , 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.









Eccentricity(e) :

a. If e=1, it is parabola

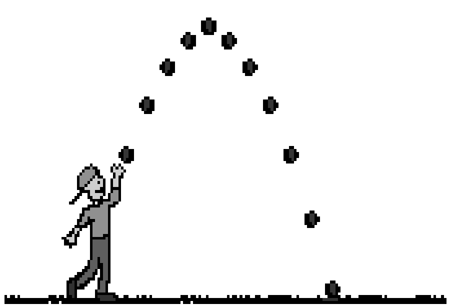
b. If e>1, it is hyperbola

c. If e<1, it is an ellipse

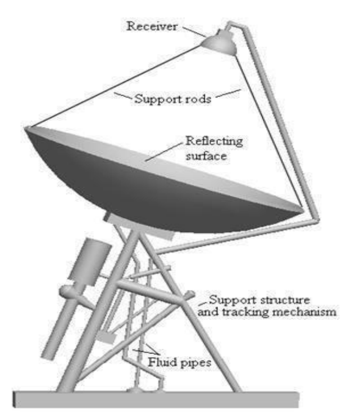
Where eccentricity e is the ratio of distance of the point from the focus to the distance of the point from the directrix.

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.



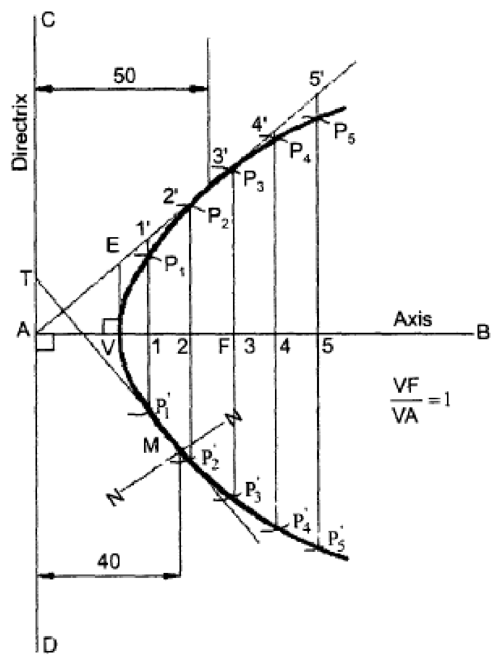
A projectile often moves horizontally as it moves upward and/or downward.



- **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.

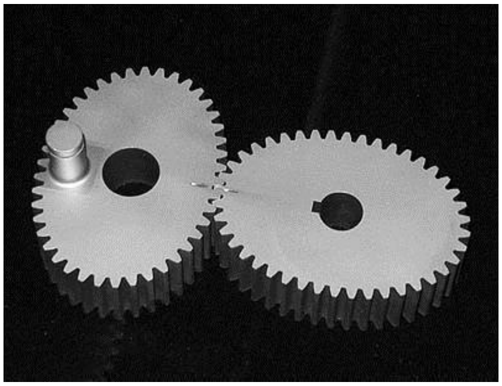


To draw a normal and tangent through a point 40mm from the directrix.

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:

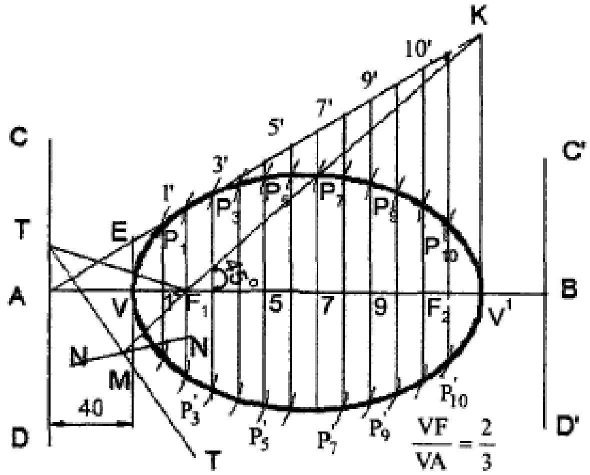
Ellipses are mostly found as harmonic oscillators, phase visualization, elliptical gears, ellipse wings.




- **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.



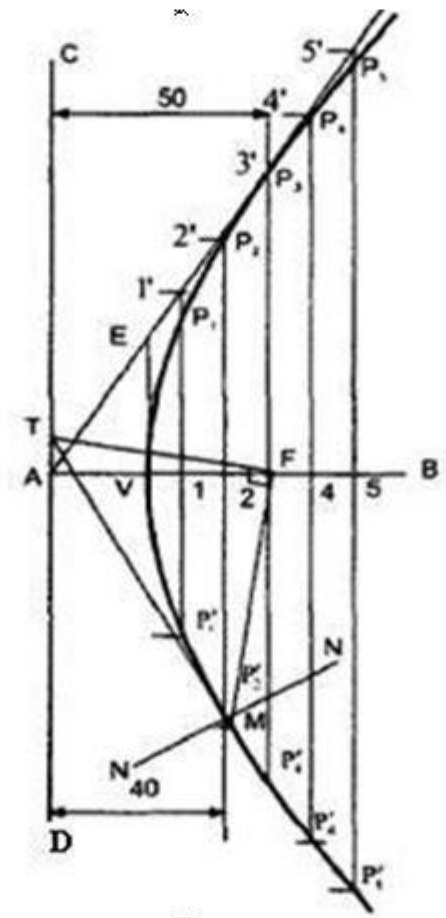
HYPERBOLA

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

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

Construction:

1. Draw the directrix 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.



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.

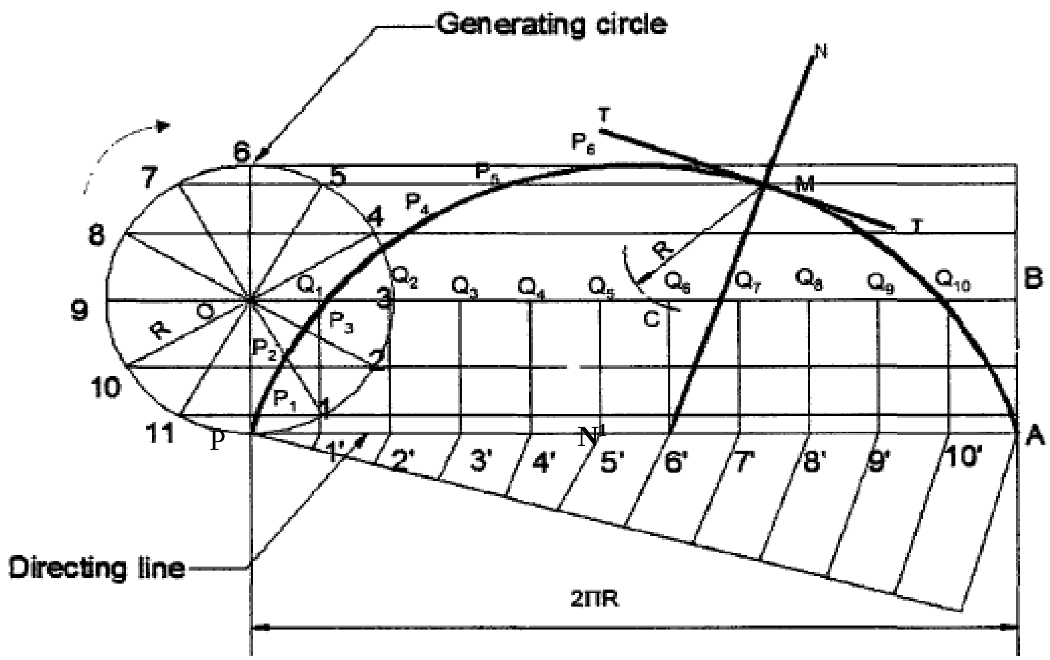
CYCLOID:

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.



• 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 Nl.
13. Join NlM and extend it to N. The line NNl is the required normal.
14. Through Point M, draw a line TTl Perpendicular to NNl. The line TTl is the required tangent.

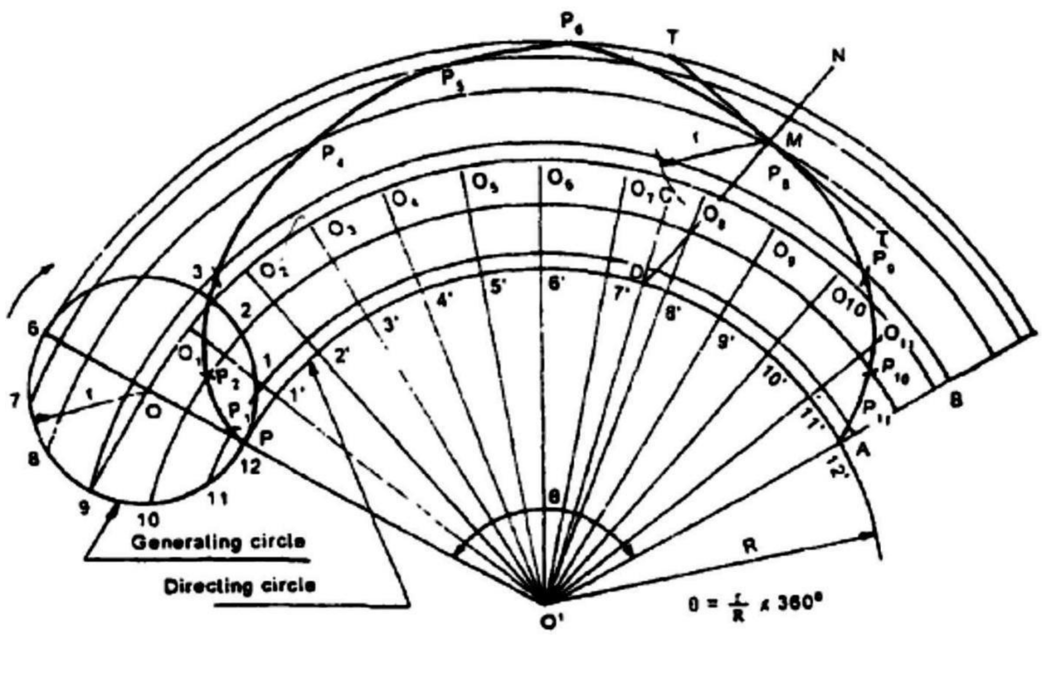
EPICYCLOID:

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 $\boldsymbol{\theta} = \boldsymbol{angle}\ PO'\boldsymbol{A} = \frac{r}{R} * \mathbf{360^0}$
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 andnumber 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.



- **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 TTl Perpendicular to DN. The line TTl is the required tangent.

HYPOCYCLOID:

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

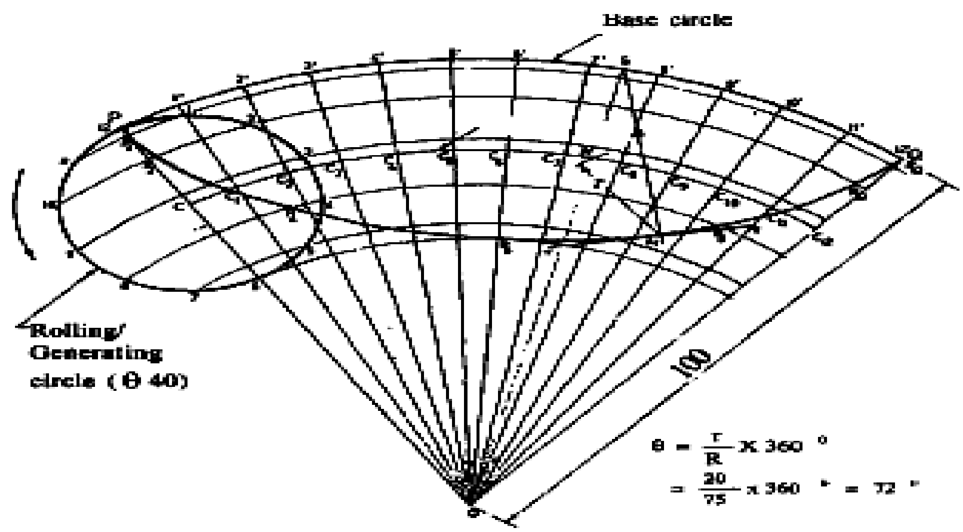
- ***Draw a hypocycloid of a circle of 40 mm diameter which rolls inside another circle of 200 mm diameter for one revolution. Draw a tangent and normal at any point on it.***

Construction:

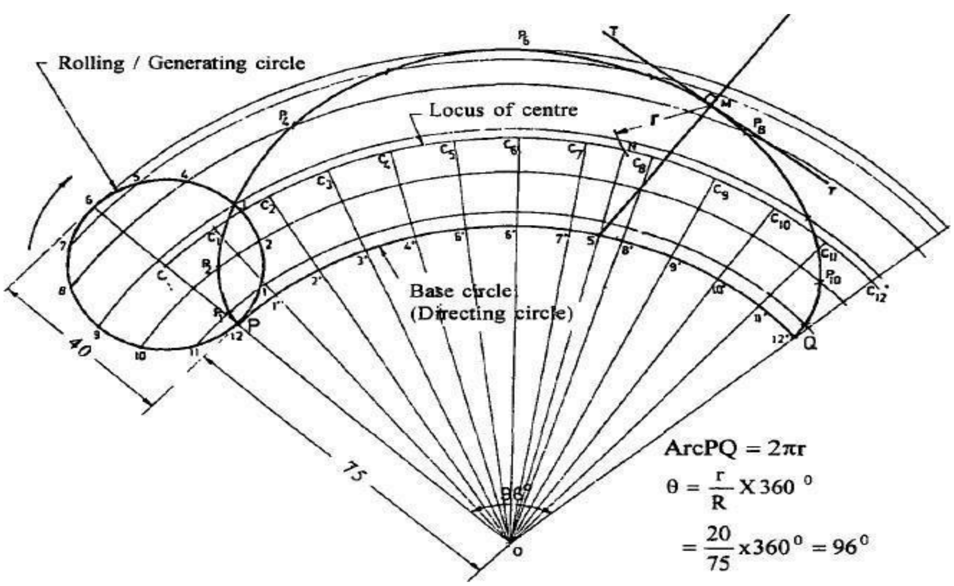
1. Taking any point O as centre and radius (R) 100 mm draw an arc PQ whichsubtends an angle θ = 72° at O. $\boldsymbol{\theta} = \boldsymbol{ang}_R\boldsymbol{le}\ PO'\boldsymbol{Q} = {}^{r} * \mathbf{360^0}$
2. Let P be the generating point. On OP mark PC = r = 20 mm, the radius of the rolling circle.
3. With C as centre and radius r (20 mm) draw the rolling circle. Divide the rolling circleinto 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.



- **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.**



UNIT – II

Introduction

What is point?

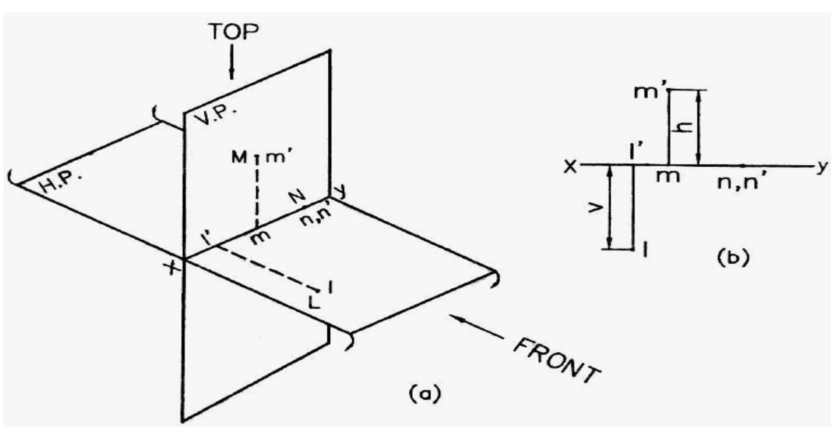
An element which has no dimensions, it can be situated in the following positions with respect to principal planes of the projections.

- 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).



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

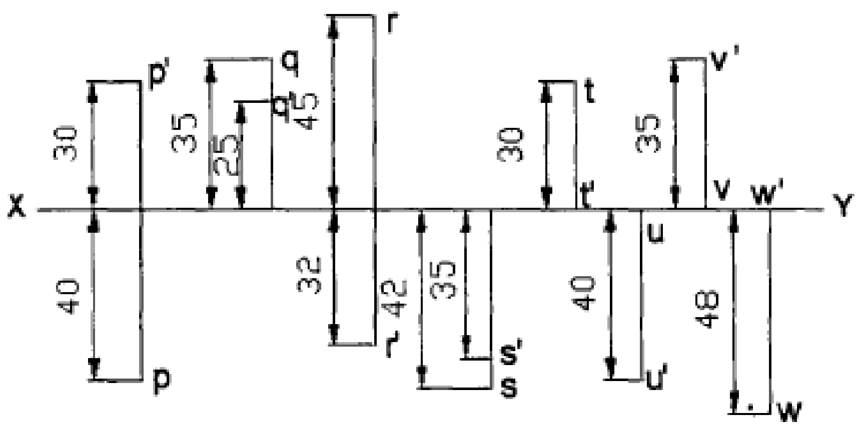
(d.) Point Sis 35 mm. below H.P and 42 mm in front of VP

(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



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

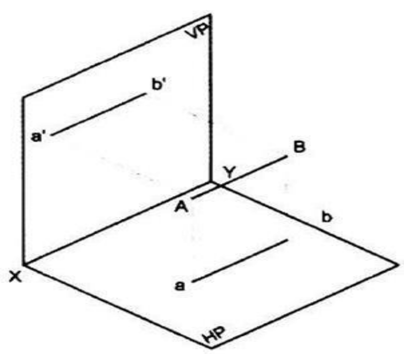
- Line parallel to both H.P and V.P
- Line perpendicular to H.P and parallel to V.P
- Line perpendicular to V.P and parallel to H.P
- Line inclined to H.P and parallel to V.P
- Line inclined to V.P and parallel to H.P
- Line situated in H.P
- Line situated in V.P
- Line situated in both H.P and V.P
- Line inclined to both the reference planes.

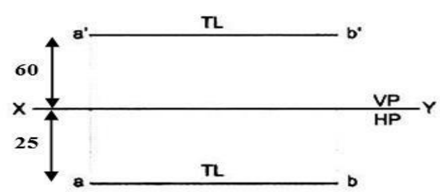
1. Line inclined to both H.P and V.P front view angle and top view angle = 90 deg
2. Line inclined to both H.P and V.P front view angle and top view angle = 90 deg

Problems

- **Line parallel to both H.P and V.P**

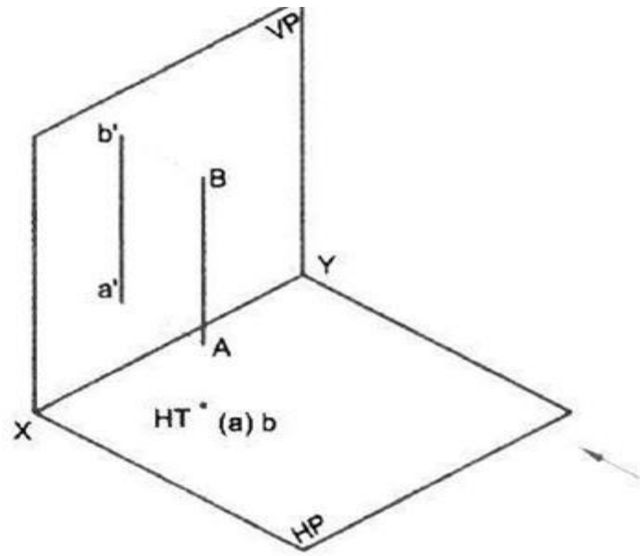
A 50mm long line AB is parallel to both H.P and V.P. The line is 25mm in front of V.P and 60mm above H.P, draw the projections of the line.

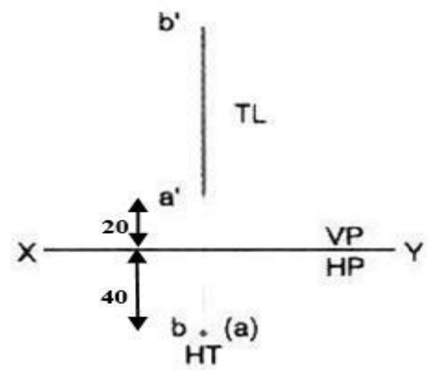




- **Line perpendicular to H.P**

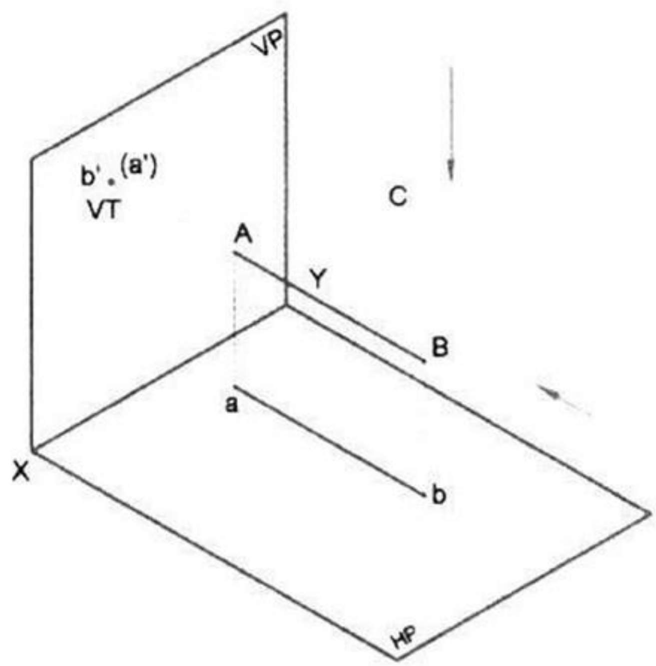
A 60mm long line AB has its end A at a distance of 20mm above the H.P. The line is perpendicular to the H.P and 40mm in front of V.P, draw the projections of the line.

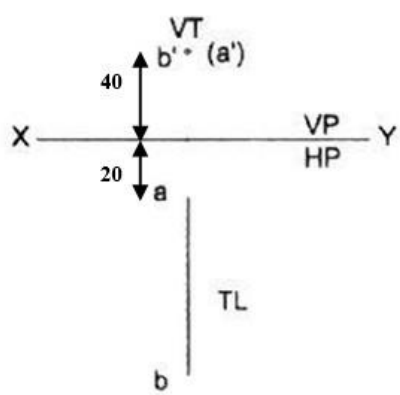




- **Line perpendicular to V.P**

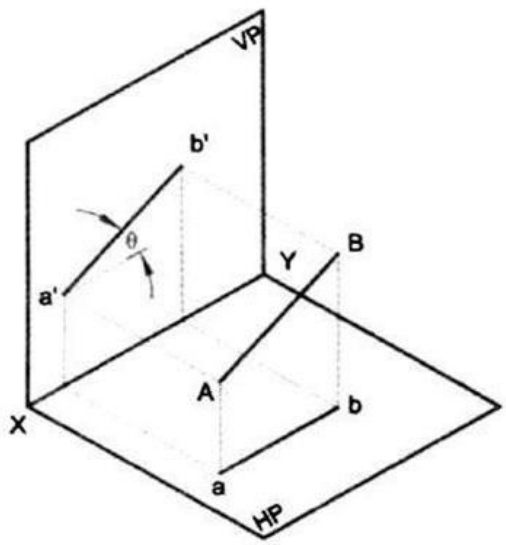
A 60mm long line AB, has its end A at a distance of 20mm in front of the V.P. the line is perpendicular to V.P and 40mm above H.P, draw the projection of the line.

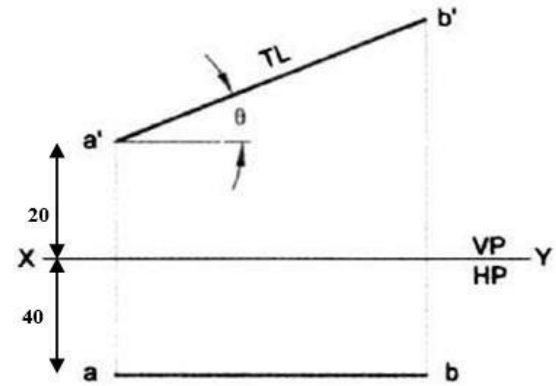




- **Line inclined to H.P and parallel to V.P**

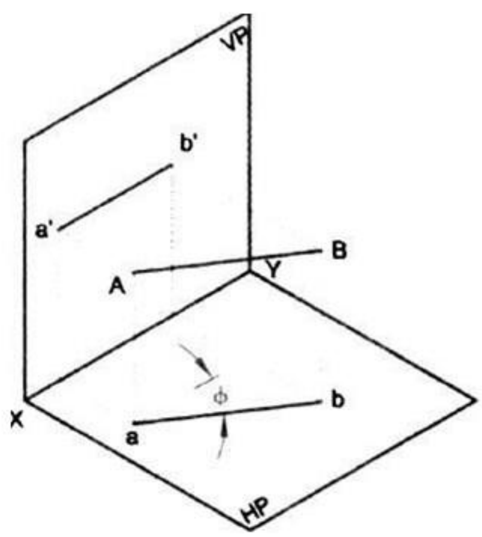
A 80mm long line AB has the end A at a distance of 20mm above HP and 40mm in front of V.P. The line is inclined at 30 deg to H.P and parallel to V.P, draw the projection of the line.

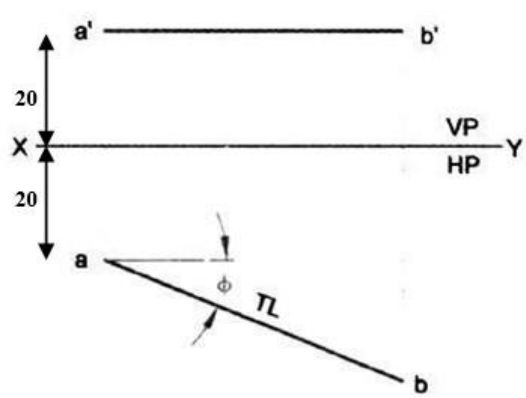




- **Line inclined to V.P and parallel to H.P**

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

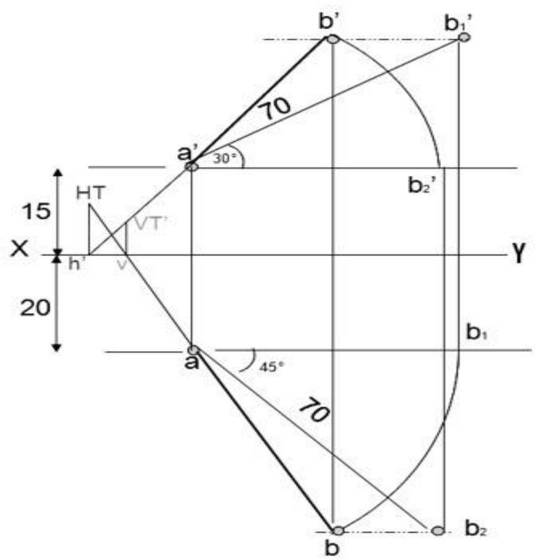




Problem:

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

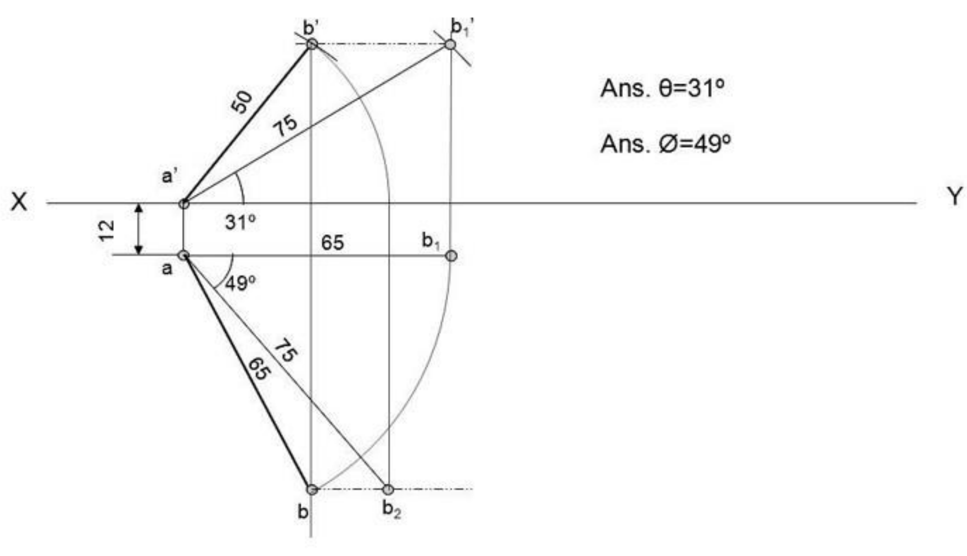
Solution:



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

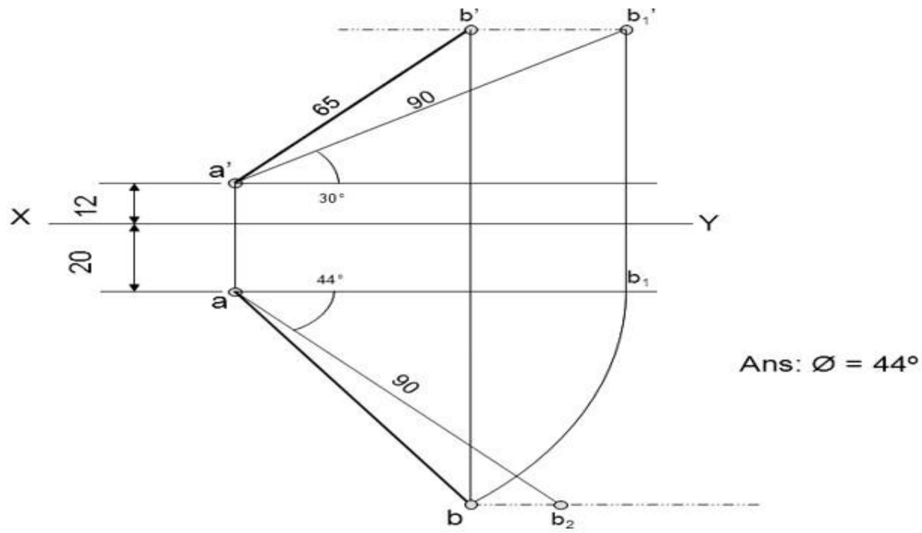
Solution:



:

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.

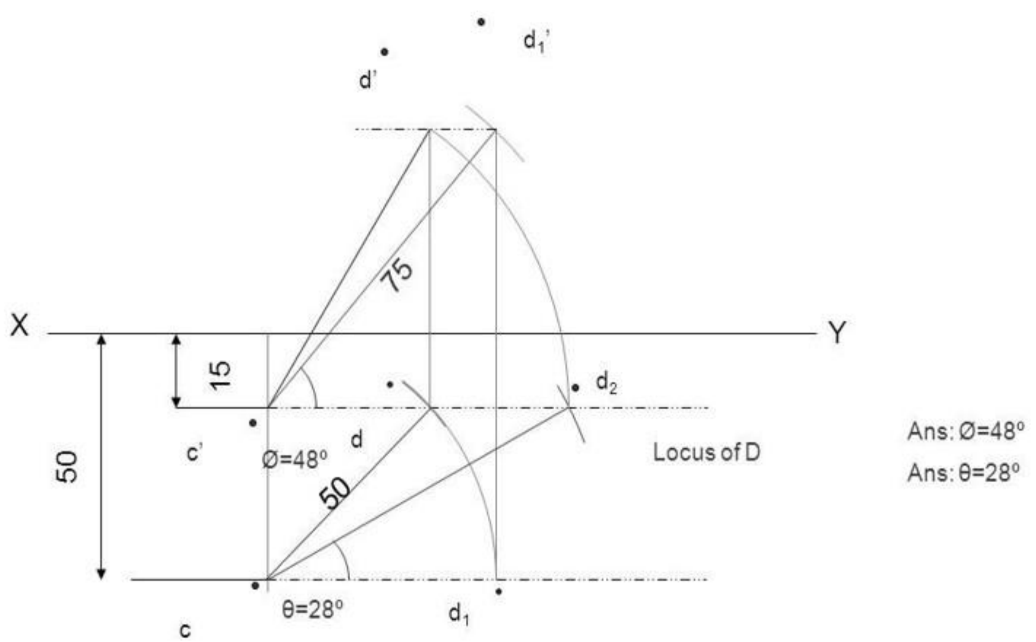
Solution:



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:



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.

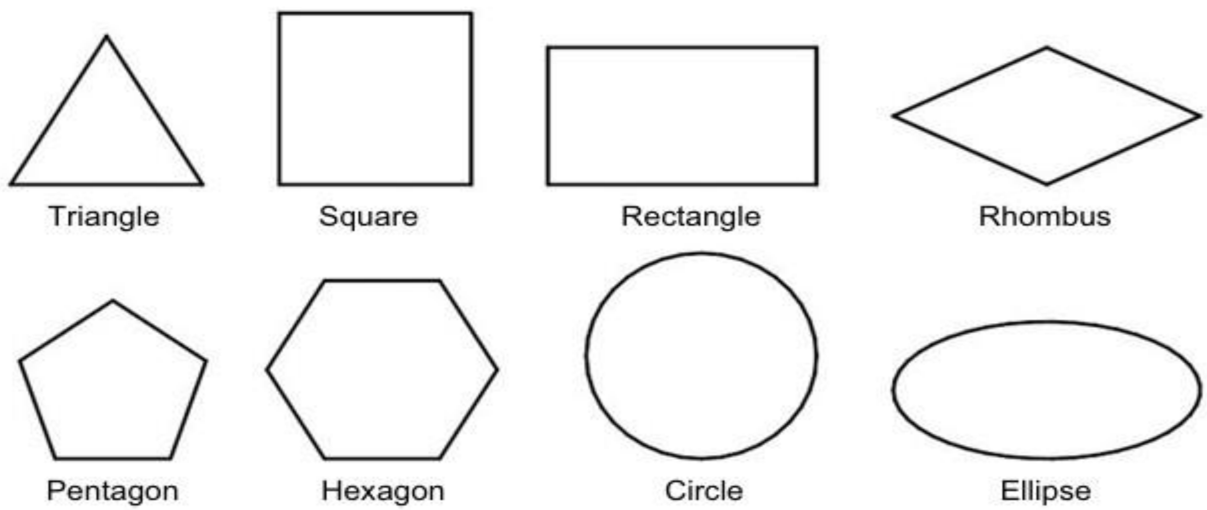
(6) The projection of a line AB has 35^0 inclination in top view and 40^0 inclination in the front view with an elevation length of 60 mm. If the end A is 10 mm below HP and B is 12 mm behind VP, Draw the projections and locate the traces keeping the line in the third quadrant.

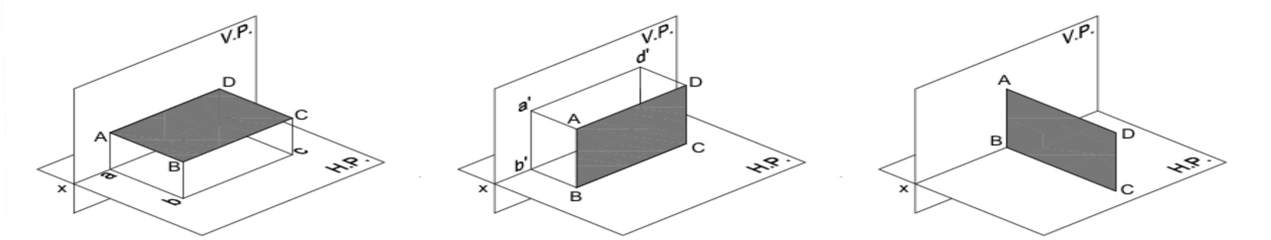
(7) Line PQ has 72 mm length in the front view and 66 mm length in the top view. The end P is 48 mm below HP and 40 mm behind VP, while the end Q is 12 mm below HP. Draw the projection of the line, locate the traces and determine the true length and inclinations of the line with the reference planes.

PROJECTION OF PLANES

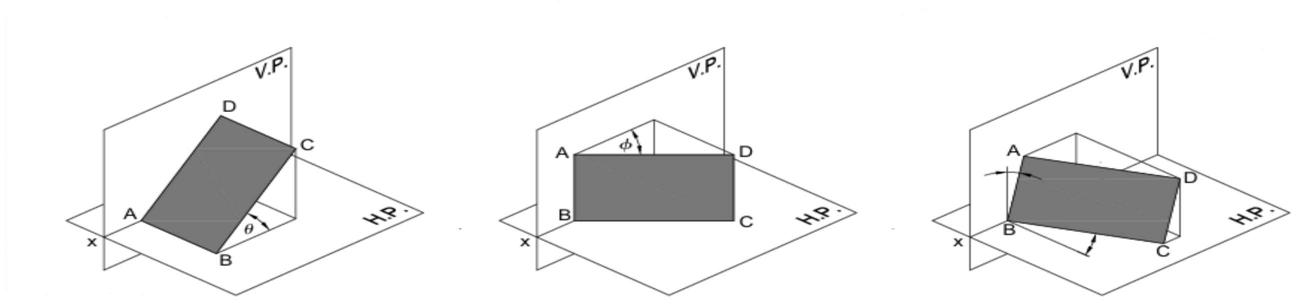
INTRODUCTION

In this chapter, we deal with two-dimensional objects called planes. Planes have length, breadth and neg ligible thickness. Here only those planes are considered whose shape can be defined geometrically and are regular in nature. Some of these are shown in Fig.





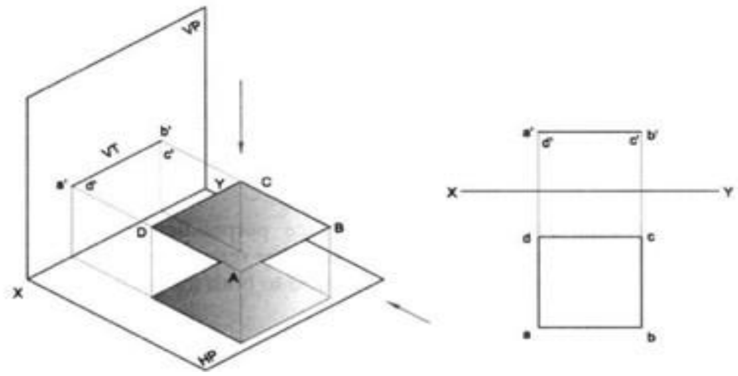
*Plane **(a)** Parallel to H.P. **(b)** Parallel to V.P. **(c)** Parallel to profile plane*



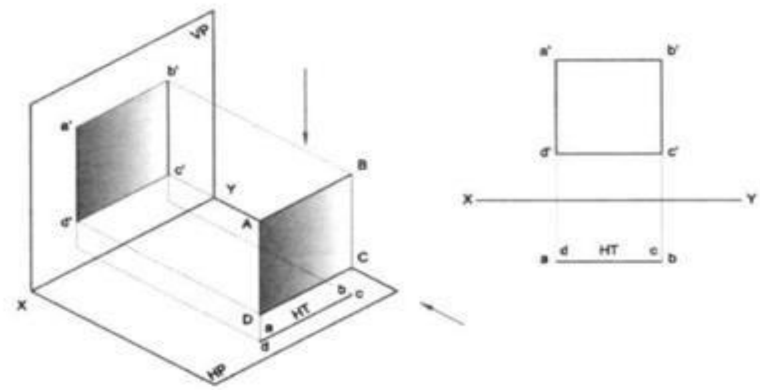
*Plane **(a)** Inclined to H.P. and perpendicular to V.P. **(b)** Inclined to V.P. and perpendicular to H.P. **(c)** Inclined to both H.P. and V.P.*

Projection of Different Planes position with respective to Principal planes

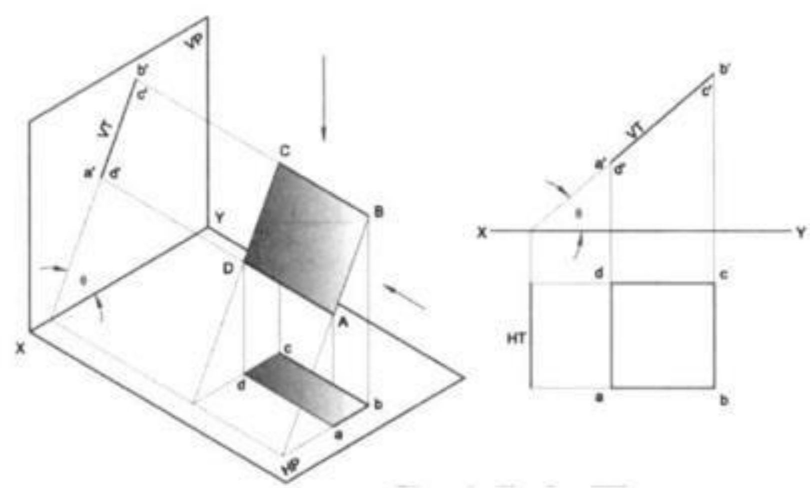
1) Surface of Plane Parallel to the HP (and perpendicular to VP)



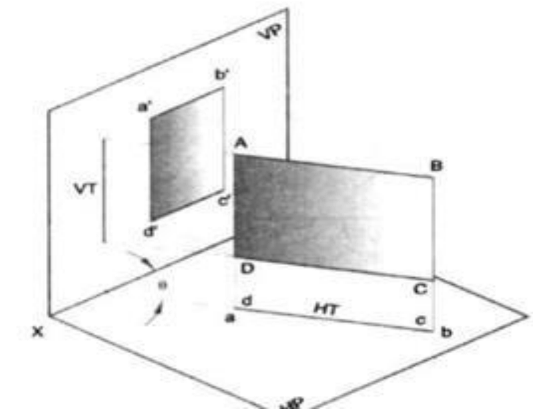
2) Surface of Plane Parallel to the VP (and perpendicular to HP)

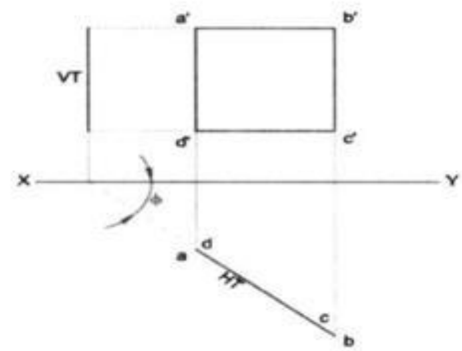


3) Surface of Plane Inclined to the HP and perpendicular to VP

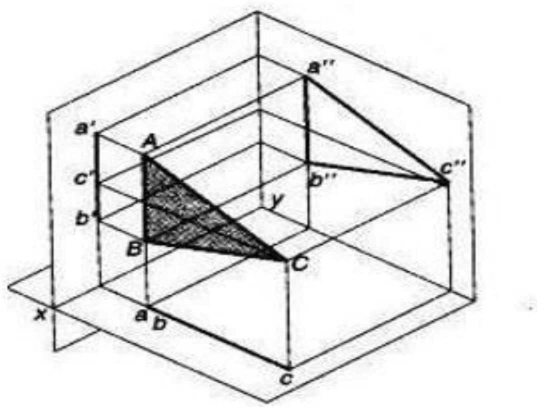


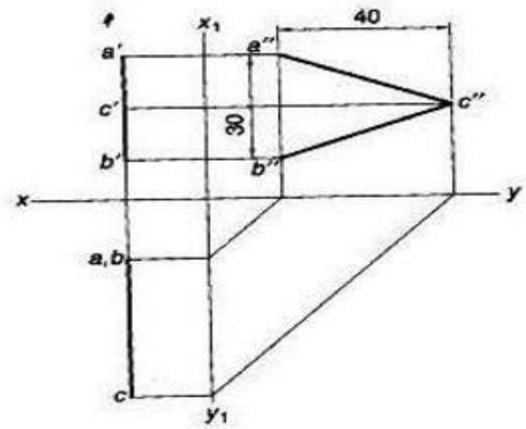
4) Surface of Plane Inclined to the VP and perpendicular to HP



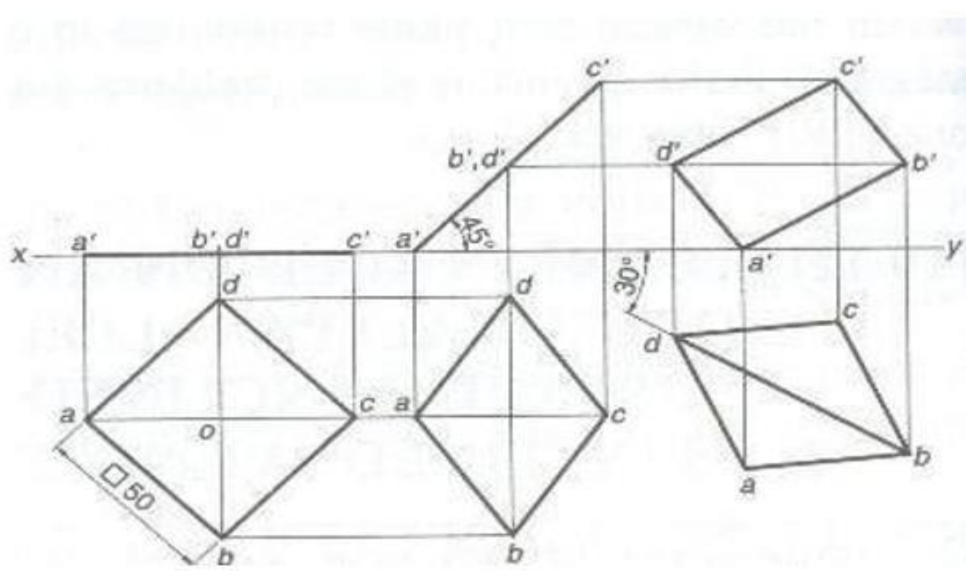


5) Surface of Plane Perpendicular to Both HP and VP





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

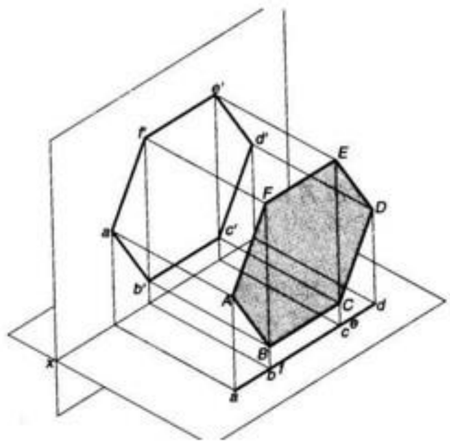


Plane Parallel to Plane Parallel to VP

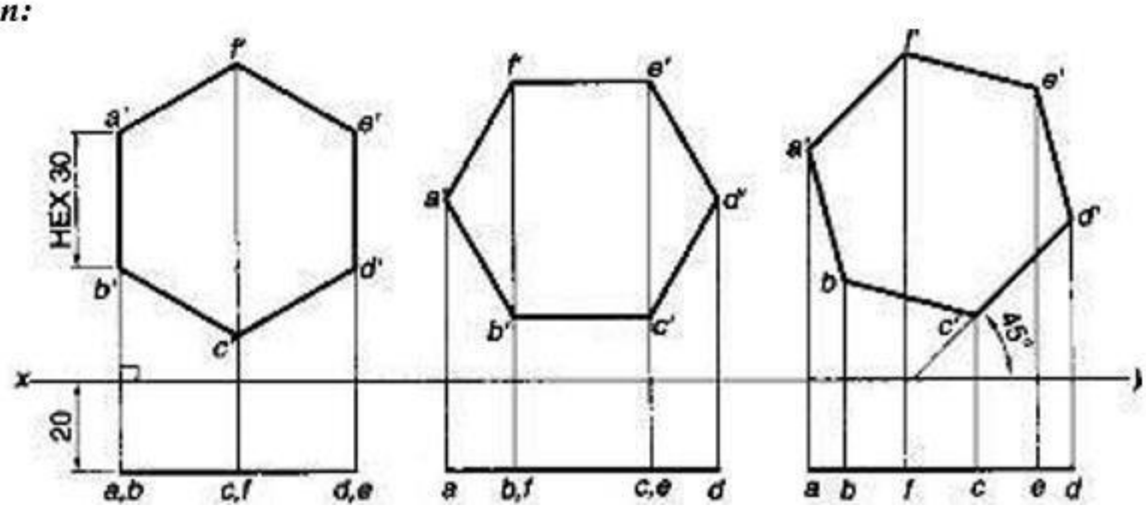
Problem:

A Hexagonal plane with a 30mm side has its surface parallel to and 20mm in front of the VP. Draw it's Projections, when (a) a side is perpendicular to HP (b) a side is parallel to the HP (c) Side is inclined at 45^0 to the HP

Visualized position of surface plane Picture:



◢ Solution:

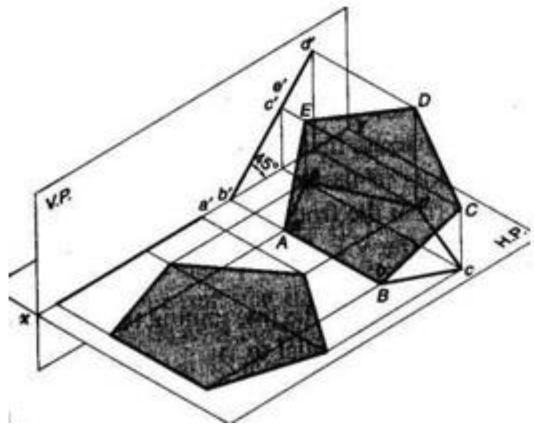


Plane is inclined to HP and Perpendicular to VP

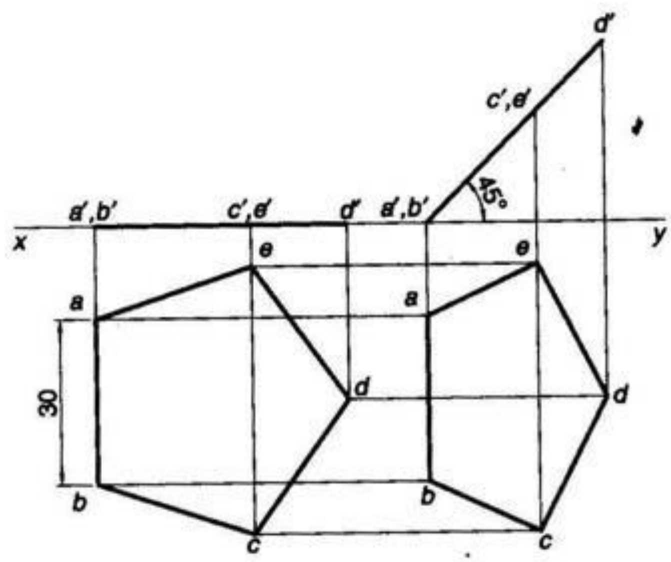
Problem:

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

Visualized position of surface plane Picture:



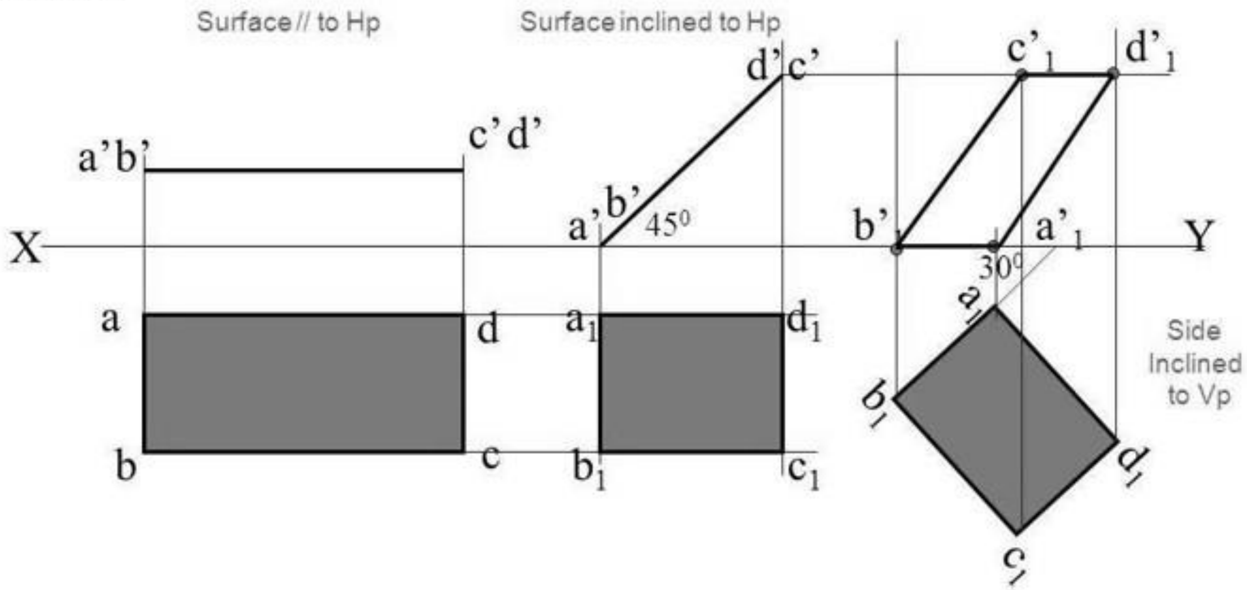
Solution:



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:



Problem:

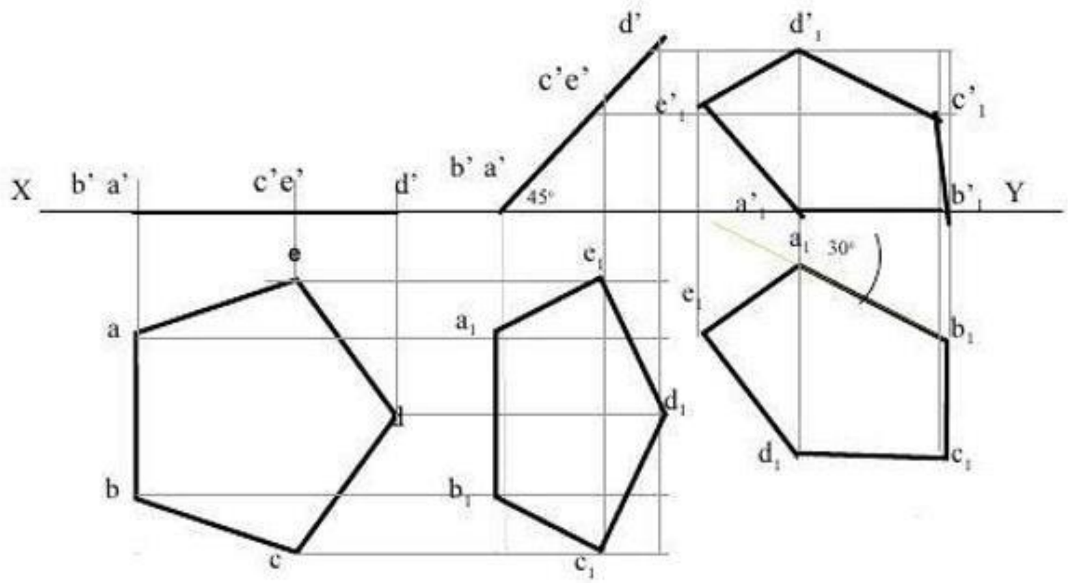
A regular pentagon of 30 mm sides is resting on HP, on one of it's sides with it's surface 45⁰ inclined to HP. Draw it's projections when the side in HP makes 30⁰ angle with VP?

***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



Problem:

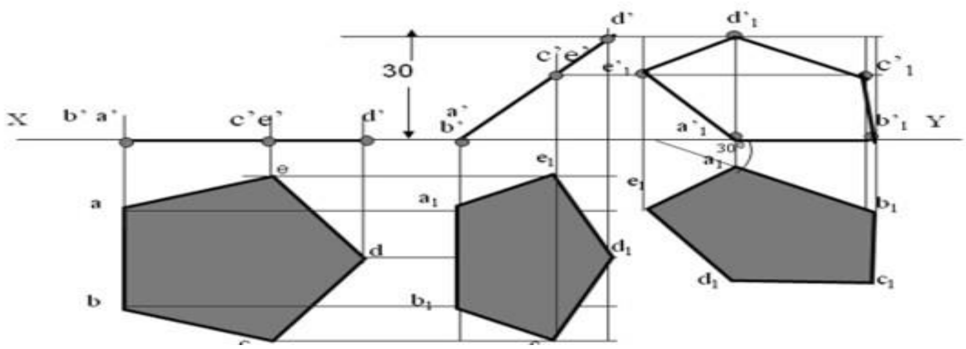
A regular pentagon of 30 mm sides is resting on HP on one of it's sides while it's opposite vertex (corner) is 30 mm above HP. Draw projections when side in HP is 30⁰ inclined to VP

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



Problem:

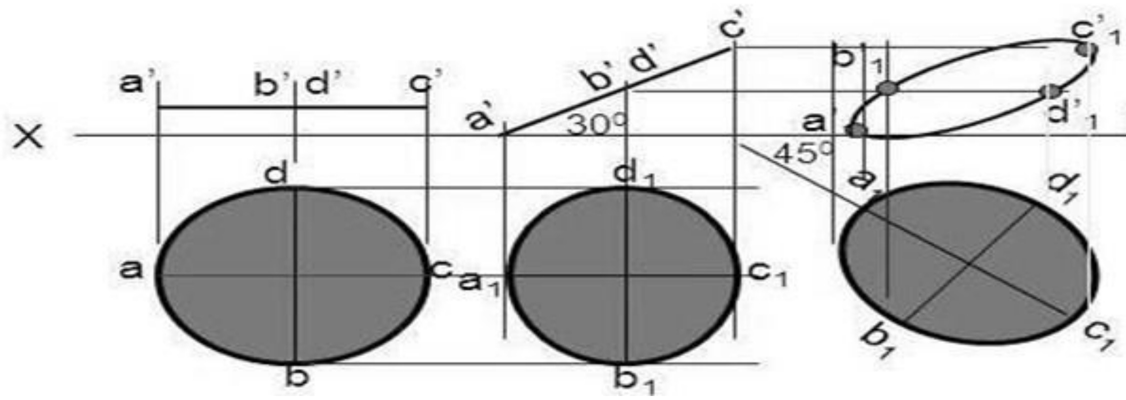
A circle of 50 mm diameter is resting on HP on end A of it's diameter AC which is 30⁰ inclined to HP while it's TV is 45⁰ inclined to VP. Draw it's Projections?

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.



UNIT - III
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

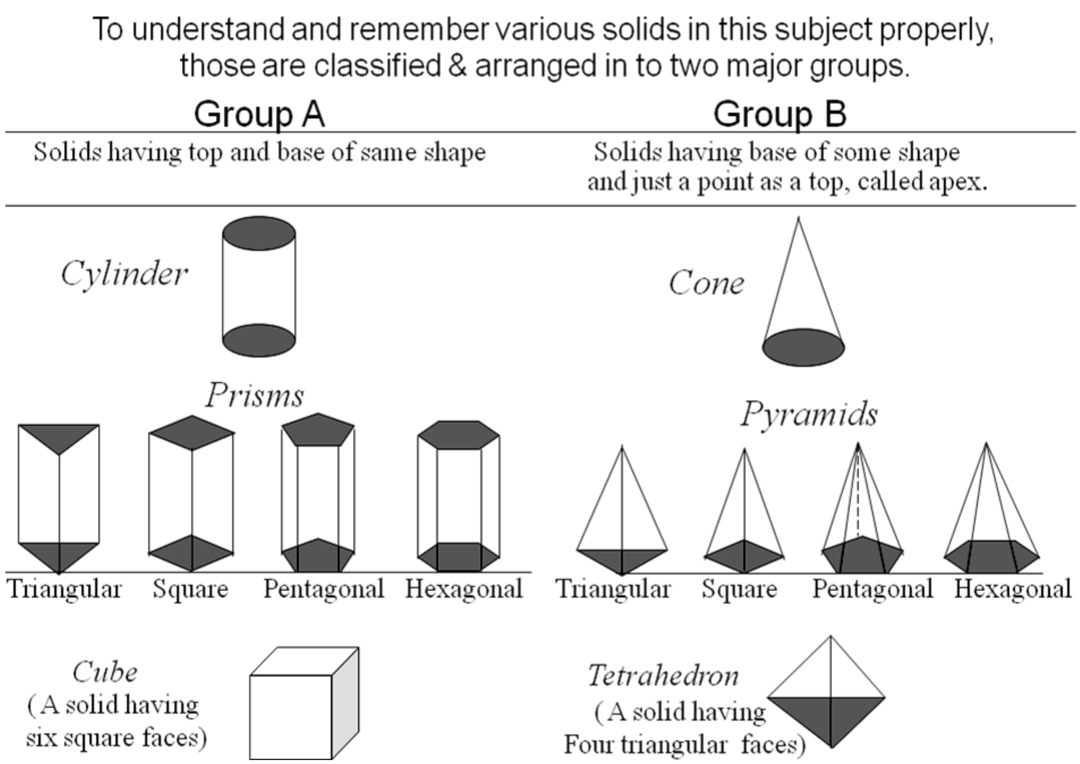
Regular Polyhedral

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 squareprism, the one with a pentagonal base is called a pentagonal prism, and so on (Fig) The nomenclatureof the prism is given in Fig.



(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.

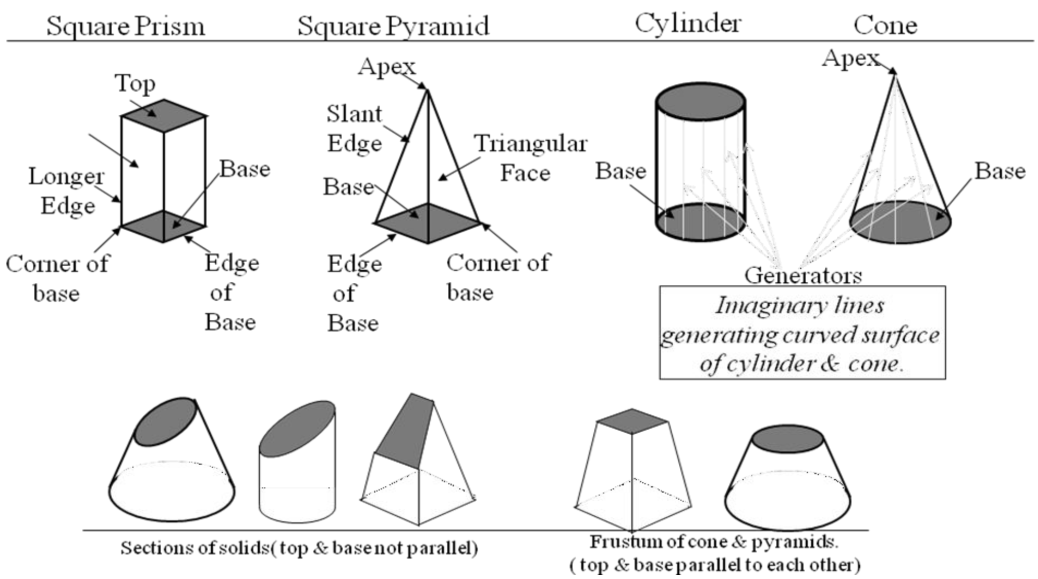
(d) Dodecahedron: It has twelve regular and equal pentagonal faces.

(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.



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.

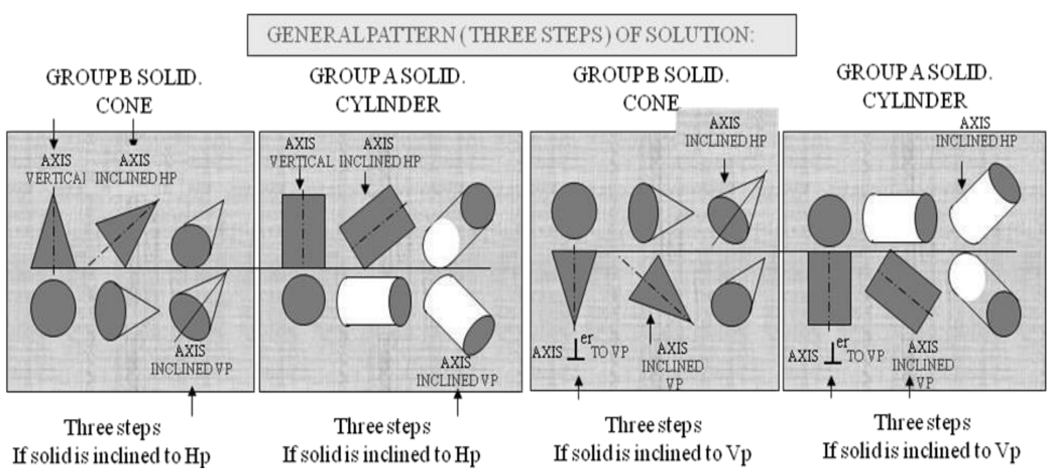
1. Axis perpendicular to one of the principal planes:

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.

Problem is solved in three steps:

STEP 1: ASSUME SOLID STANDING ON THE PLANE WITH WHICH IT IS MAKING INCLINATION.
(IF IT IS INCLINED TO HP, ASSUME IT STANDING ON HP)
(IF IT IS INCLINED TO VP, ASSUME IT STANDING ON VP)
IF STANDING ON HP - IT'S TV WILL BE TRUE SHAPE OF IT'S BASE OR TOP:
IF STANDING ON VP - IT'S FV WILL BE TRUE SHAPE OF IT'S BASE OR TOP.
BEGIN WITH THIS VIEW:
IT'S OTHER VIEW WILL BE A RECTANGLE (IF SOLID IS *CYLINDER OR ONE OF THE PRISMS*):
IT'S OTHER VIEW WILL BE A TRIANGLE (IF SOLID IS *CONE OR ONE OF THE PYRAMIDS*):
DRAW FV & TV OF THAT SOLID IN STANDING POSITION:
STEP 2: CONSIDERING SOLID'S INCLINATION (AXIS POSITION) DRAW IT'S FV & TV.
STEP 3: IN LAST STEP, CONSIDERING REMAINING INCLINATION, DRAW IT'S FINAL FV & TV.



Simple Problems:

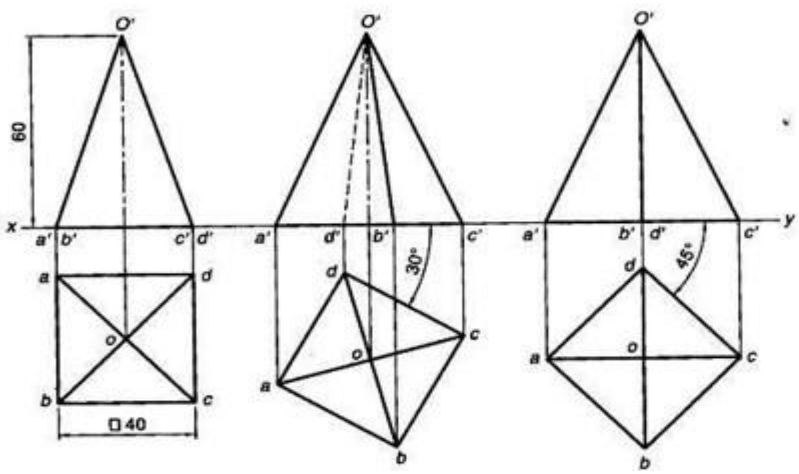
When the axis of solid is perpendicular to one of the planes, it is parallel to the other. Also, the projection of the solid on that plane will show the true shape of the base. When the axis of a solid is perpendicular to H.P, the top view must be drawn first and then the front view is projected from 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 30^0 to the VP and (c) All the sides of base are equally inclined to the VP.

Solution:

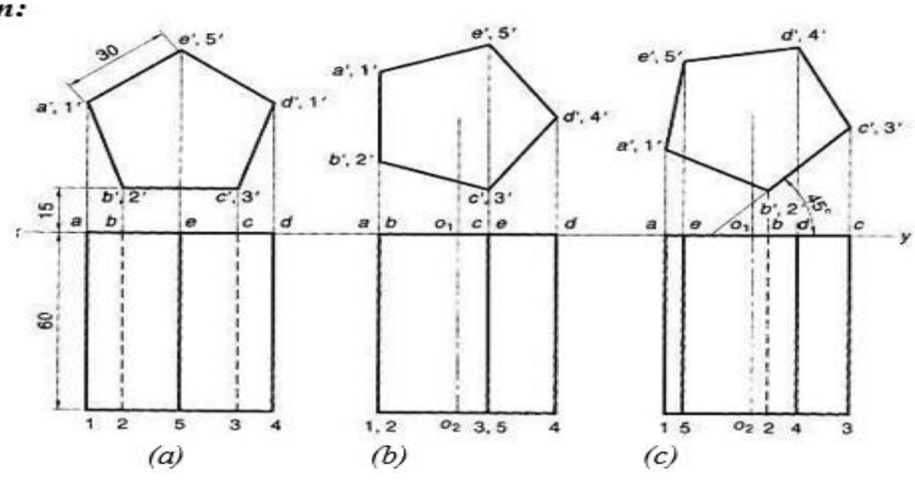


2. Axis perpendicular to VP

Problem:

A pentagonal Prism having a base with 30 mm side and 60mm long Axis, has one of It's bases in the VP. Draw Its projections When (a)rectangular face is parallel to and 15 mm above the HP (b) A rectangular face perpendicular to HP and (c) a rectangular face is inclined at 45^0 to the HP

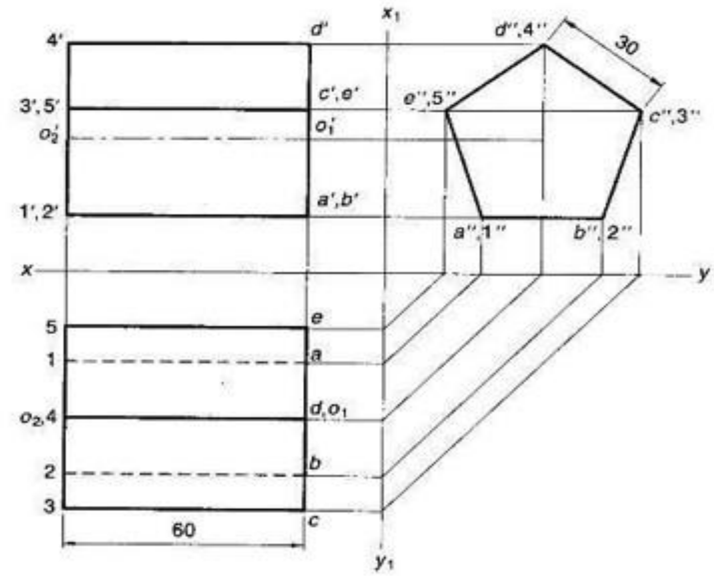
Solution:



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?

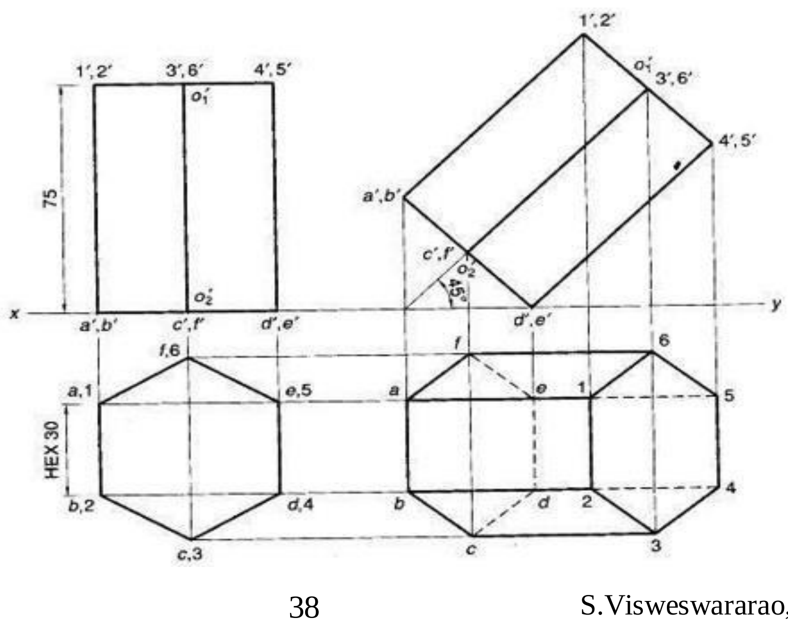
Solution:



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 45^0 to the HP Draw its projections?

Solution:

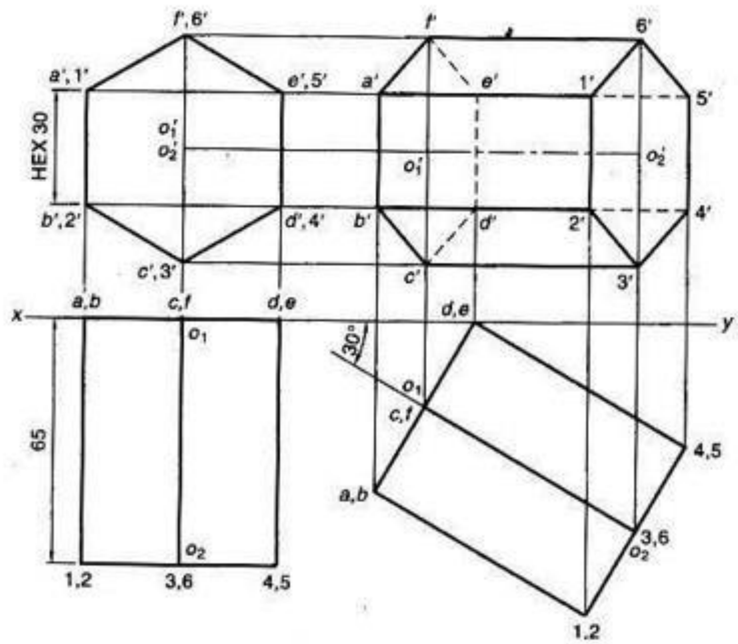


5. Axis inclined to VP and parallel to HP

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 30^0 to the VP and Parallel to the HP. Draw its Projections?

Solution:



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.

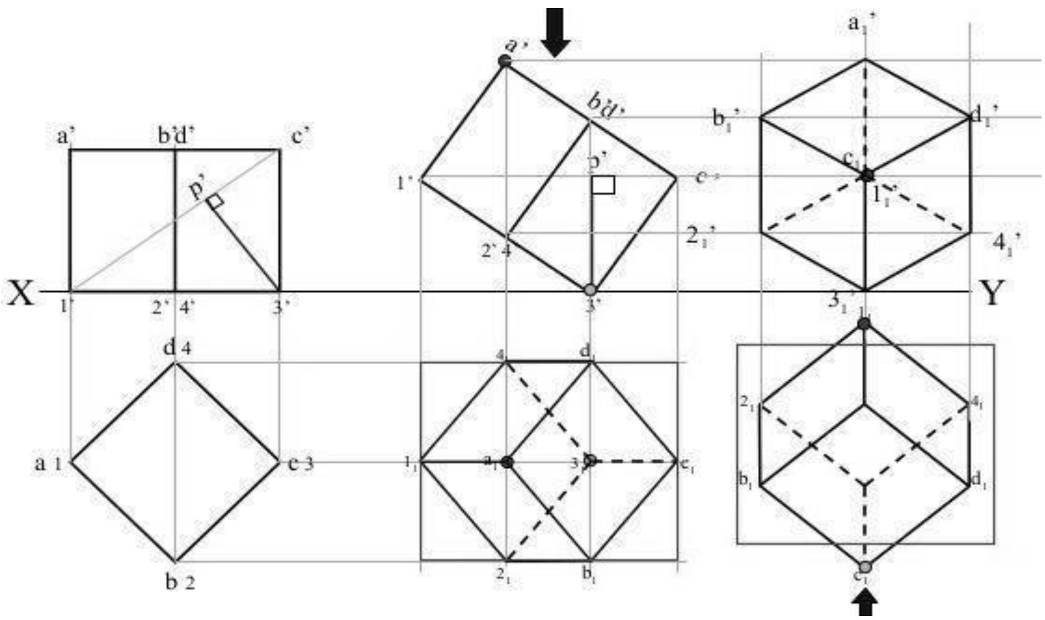
Problem:

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.

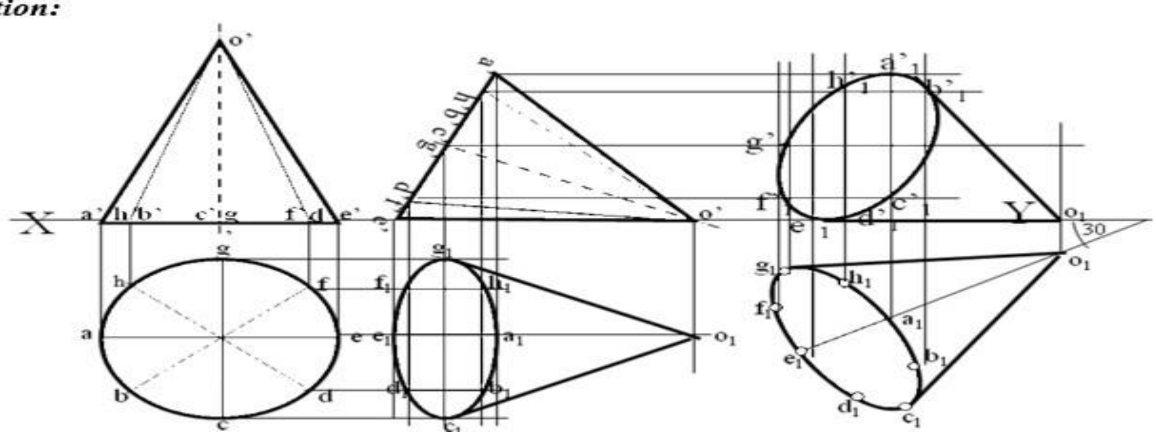


Problem:
A cone 40 mm diameter and 50 mm axis is resting on one of its generator on HP which makes 30^0 inclinations with VP. Draw it’s projections?

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 2^{nd} 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 30^0 to xy as shown) & project final FV.

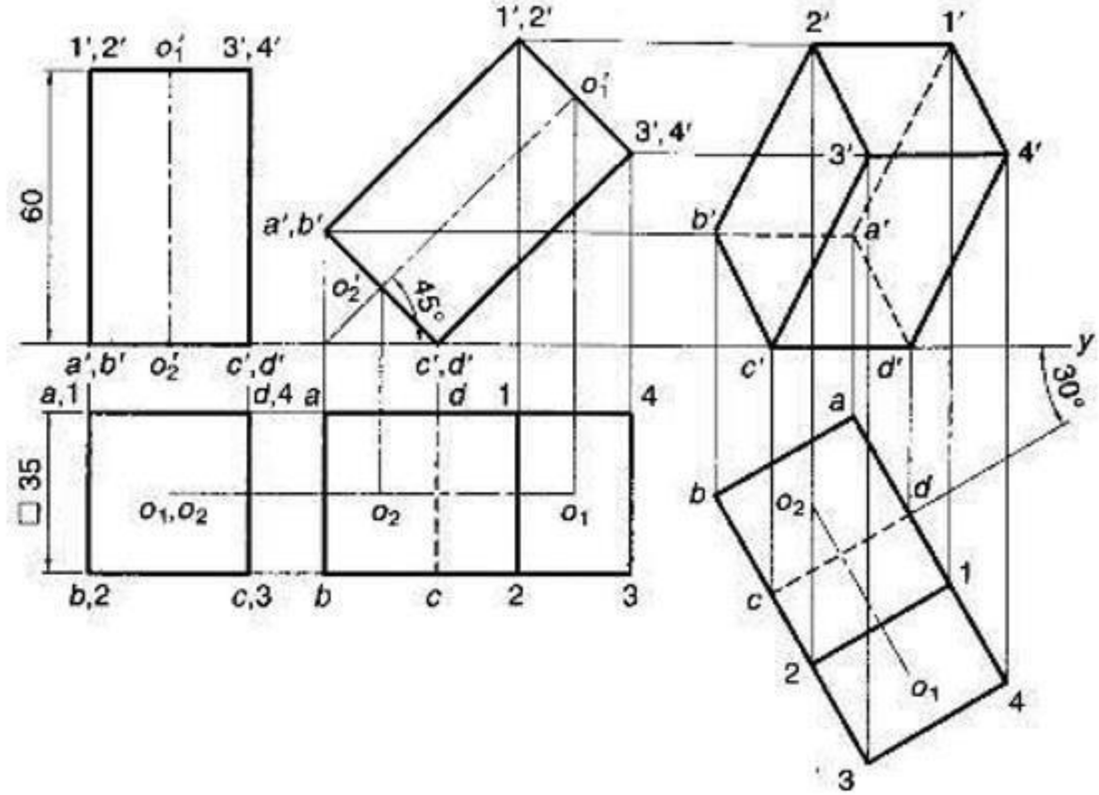
Solution:



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:



Problem:

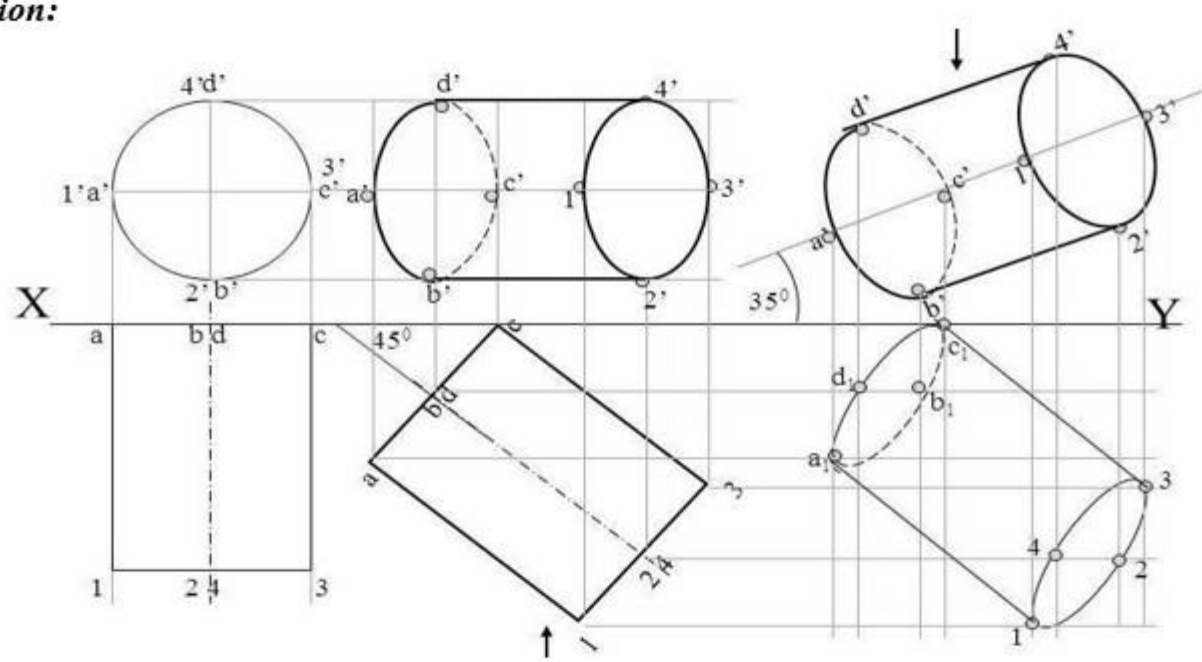
A cylinder 40 mm diameter and 50 mm axis is resting on one point of a base circle on VP while it's axis makes 45^0 with VP and FV of the axis 35^0 with HP. Draw its projections.

Solution Steps:

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

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

Solution:



SECTIONS OF SOLID:

The orthographic views of a solid may contain a number of dotted lines. These lines indicate the presence of hidden details which may lie behind or somewhere in the middle of the object. The interpretation of the object's shape becomes difficult with increasing number of such lines. As a remedy, it becomes obligatory to draw sectional views for a better and easier interpretation of the internal features. The present chapter describes the methods of obtaining sectional views and other related drawing.

The object is considered to be cut by a plane called a section plane or a cutting plane. The portion of the object, which falls between the section plane and the observer, is assumed to be removed. Thus the internal details become visible. The projections of the remaining object are termed as sectional views. It is always convenient to start by drawing the orthographic views of the uncut object. Then these are modified into sectional views. The cut surface which is common to the object and the section plane is shaded with parallel lines called hatching to differentiate it from other surfaces. If the section plane is inclined to the plane of projection, the cut surface does not show its true shape. In such cases, it is generally required to determine the true shape of the cut surface popularly called the true shape of section.

TERMINOLOGY The following terms are frequently used in this chapter:

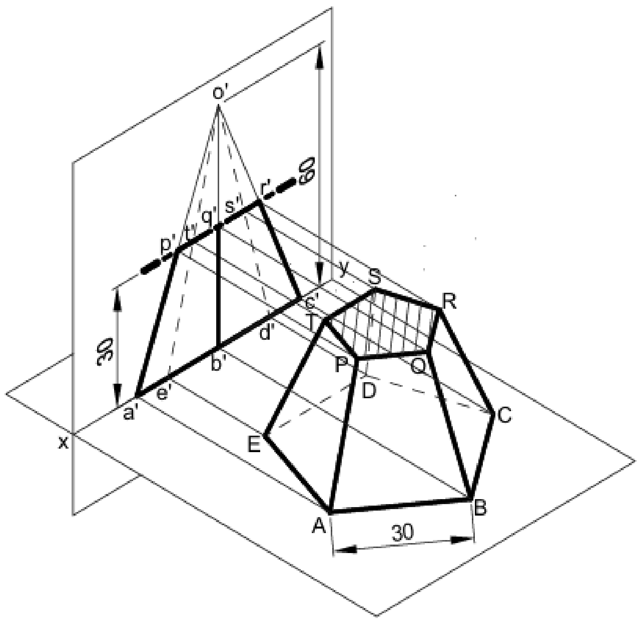
1. Section plane It is an imaginary plane which cuts the given object to show the internal details. This plane is represented by its trace.
2. Cut surface It is the surface created due to cutting the object by section plane. It is shown by hatching lines.
3. Hatching lines These are used to indicate the cut surface. These are represented by continuous lines drawn at 45º to the reference line, parallel to each other at a uniform spacing of 2 to 3 mm.
4. Apparent section It is the projection of cut surface when the section plane is not parallel to the plane of projection.
5. True shape of section The projection of the cut surface on a plane parallel to the section plane is known as true shape of section. It shows actual shape and size of the cut surface.

Problem

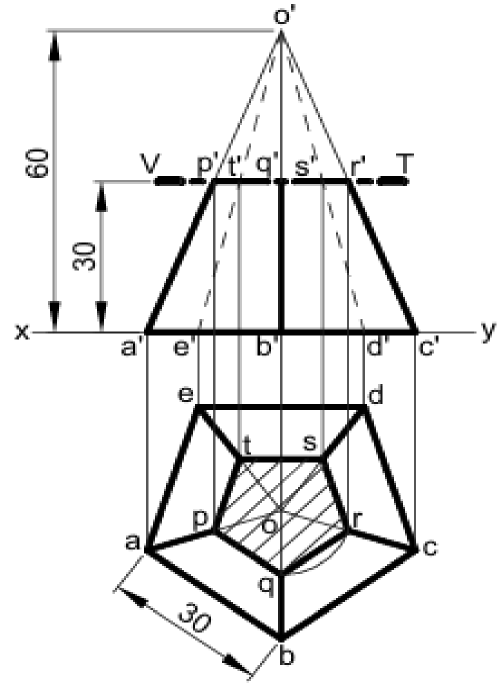
A pentagonal pyramid of base side 30 mm and axis 60 mm is resting on its base in the H.P. with an edge of the base parallel to the V.P. A horizontal section plane cuts the pyramid bisecting the axis. Draw its front view and sectional top view.

1. Projections Draw a pentagon abcde keeping side de parallel to xy. Join all the corners of the pentagon with centroid o. This is the top view. Project all the corners and obtain a'c'o' as the front view.
2. Cutting plane Draw V.T. of the section plane parallel to and 30 mm above xy. Let V.T. cut the slant edges o'a' at p', o'b' at q', o'c' at r', o'd' at s' and o'e' at t'.
3. Sectional top view Project p', r', s' and t' on their respective edges oa, oc, od and oe and obtain points p, r, s and t. Point q' cannot be projected directly on ob. However, it is known that the sec tional top view should be a regular pentagon. Therefore, draw an arc with centre o and radius ro to meet ob at point q. Join pqrst and hatch the enclosed portion.

As the section plane is parallel to the H.P., pqrst represents the true shape of the section.

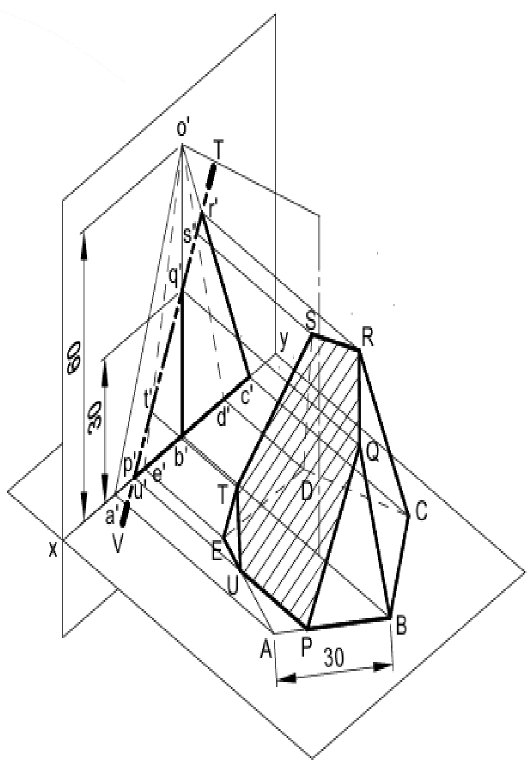


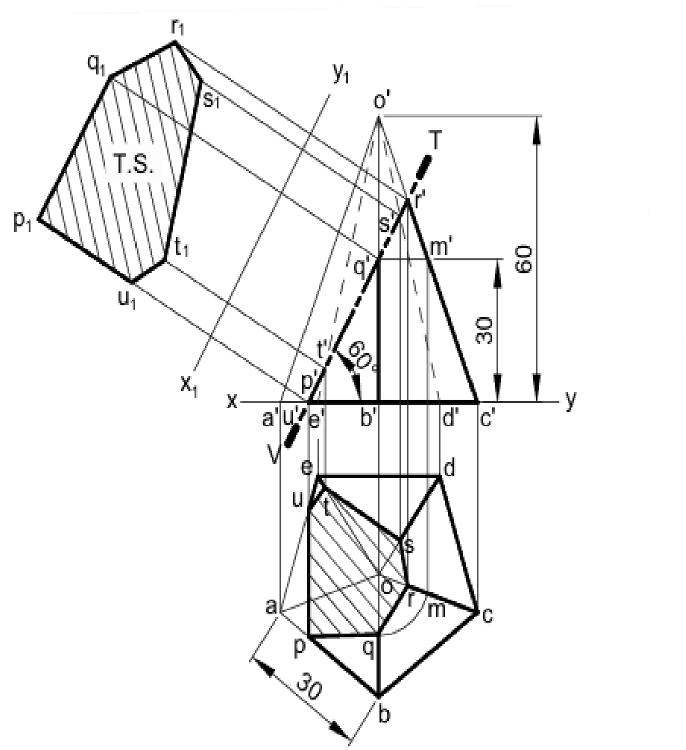
(a)



Problem

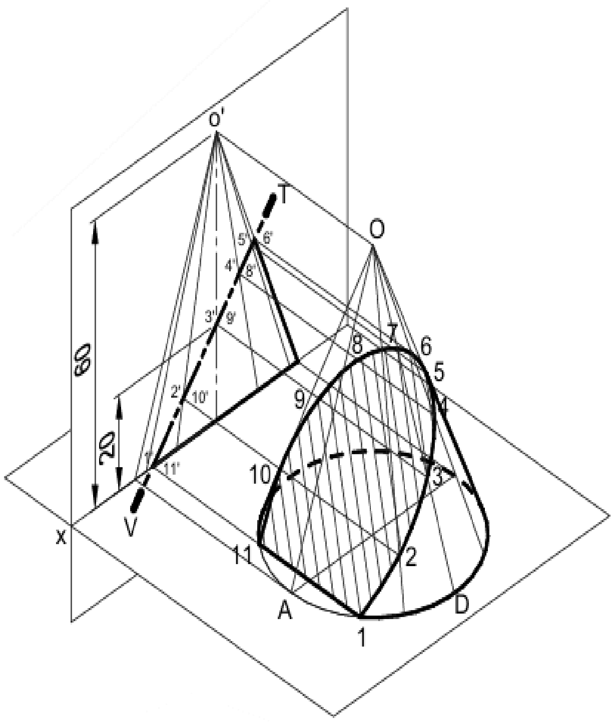
A pentagonal pyramid of base side 30 mm and axis 60 mm is resting on its base on the H.P. with an edge of the base parallel to the V.P. It is cut by a section plane perpendicular to the V.P., inclined at 60° to the H.P. and bisecting the axis. Draw its front view and sectional top view and true shape of the section.

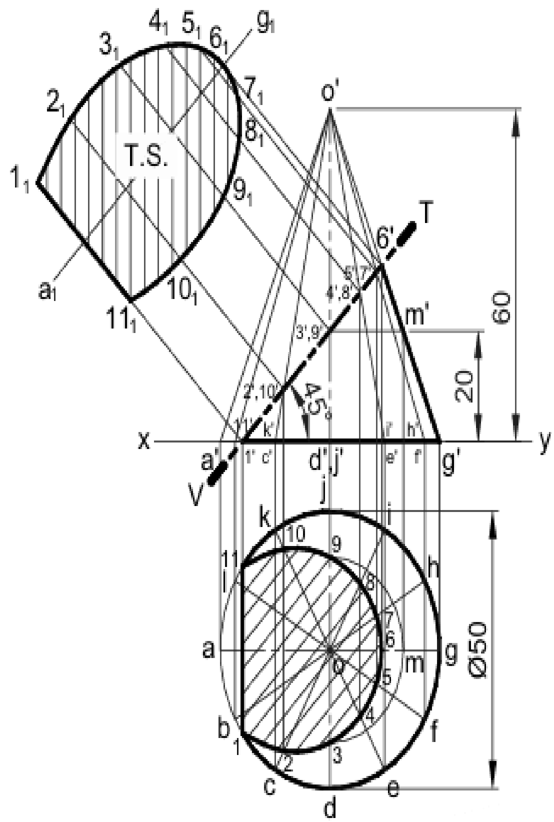




Problem

A cone of base diameter 50 mm and axis 60 mm is resting on its base on the H.P. It is cut by an A.I.P. inclined at 45° to the H.P. and passing through a point on the axis, 20 mm above the base. Draw its sectional top view and obtain true shape of the section.



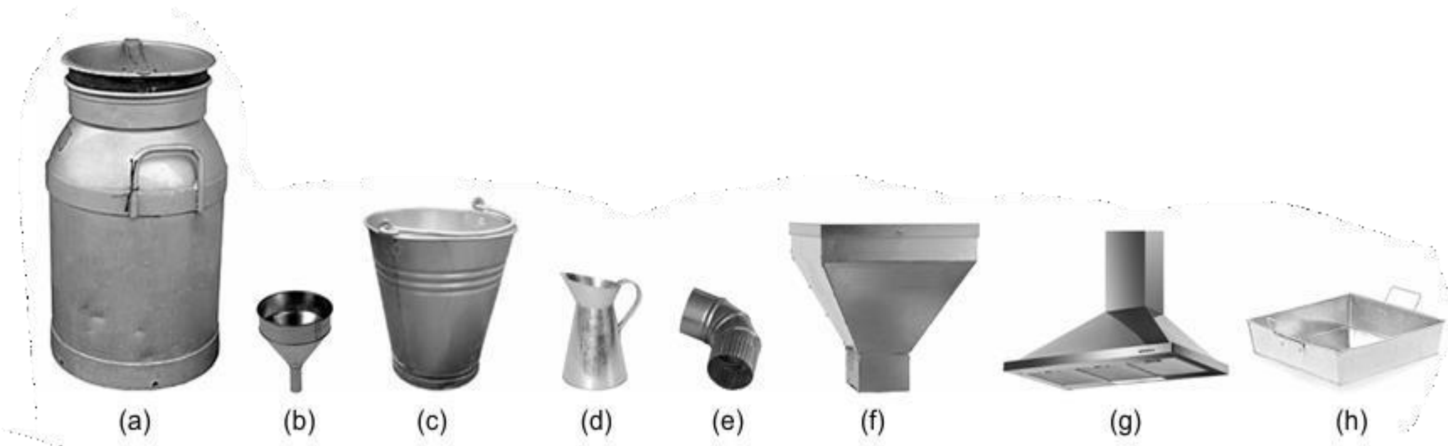


1. Projections Draw a circle adgj to represent the top view. Divide the circle into 12 equal parts and project to obtain a'g'o' as the front view.
2. Cutting plane Draw V.T. of the section plane inclined at 45° to xy and passing through a point 3' lying on the axis at a height of 20 mm from the base.
3. Sectional top view Let V.T. cut the base at 1' and 11' while the generators o'c' at 2', o'd' at 3', o'e' at 4', o'f' at 5', o'g' at 6', o'h' at 7', o'i' at 8', o'j' at 9' and o'k' at 10'. Project 1', 2', 4', 5', 6', 7', 8', 10' and 11' to meet in the top view at points 1, 2, 4, 5, 6, 7, 8, 10 and 11.
4. Points 3' and 9' cannot be projected directly on od and oj. For this draw a horizontal line from 3' to meet o'g' at m'. Project m' to meet og at m. Draw an arc with centre o and radius om to meet od and oj at points 3 and 9 respectively.
5. Join 1-2-3-4-5-6-7-8-9-10-11 and hatch the enclosed space.

UNIT – IV
DEVELOPMENT OF SURFACE

INTRODUCTION

The development of surface is the shape of a plain sheet that by proper folding could be converted into the desired object. In engineering practice, a large number of objects like milk can, funnel, bucket, measuring flask, duct of air conditioner, hopper, chimney, tray, storage tank, boiler shell etc. shown in Fig., are made of metal sheets. The fabrication of these objects can be planned in an economic way if the accurate shape and size of metal sheet is known. This chapter deals with proper layout planning of the surface of the object on a single plane called the development of surfaces.

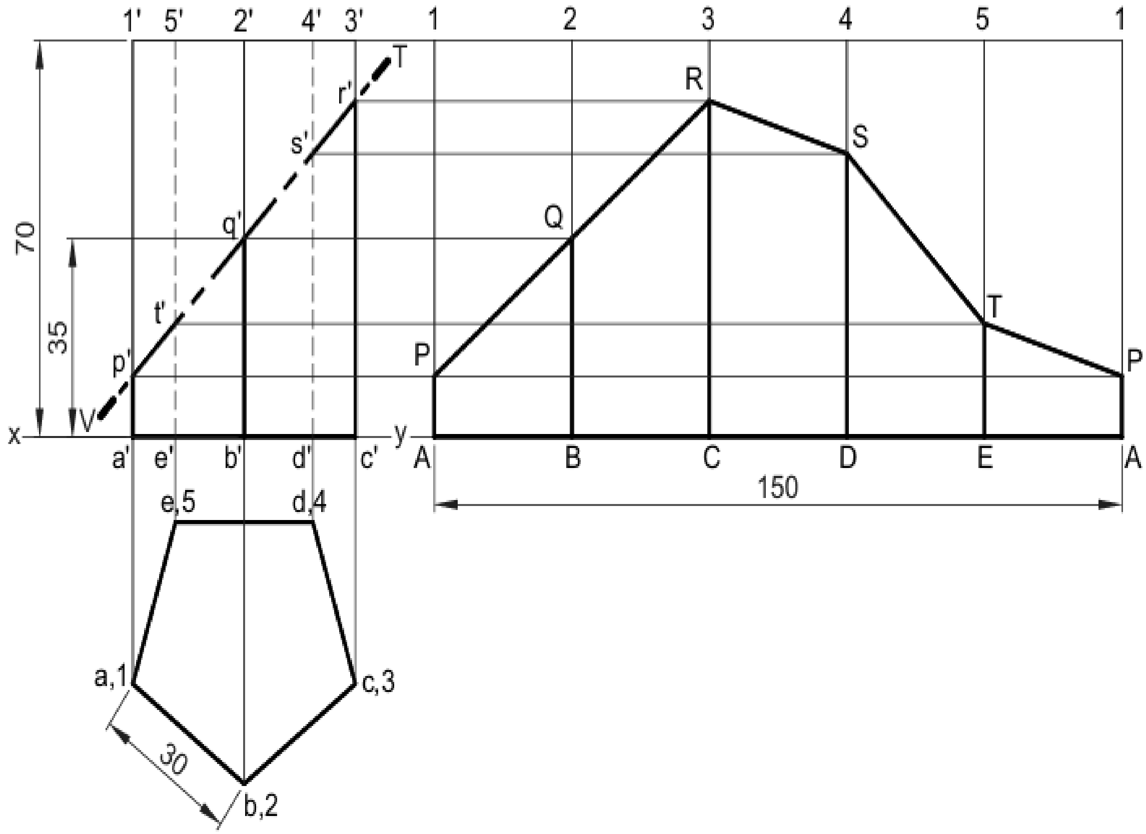


Metal sheet used for making **(a)** *Milk can* **(b)** *Funnel* **(c)** *Bucket* **(d)** *Measuring flask* **(e)** *Duct of air conditioner* **(f)** *Hopper* **(g)** *Chimney* **(h)** *Tray*

Problem

A pentagonal prism of base side 30 mm and axis 70 mm is resting on its base on the H.P. with a rectangular face parallel to the V.P. It is cut by an auxiliary inclined plane (A.I.P.) whose V.T. is inclined at 45° to the reference line and passes through the mid-point of the axis. Draw the develop ment of the lateral surface of the truncated prism.

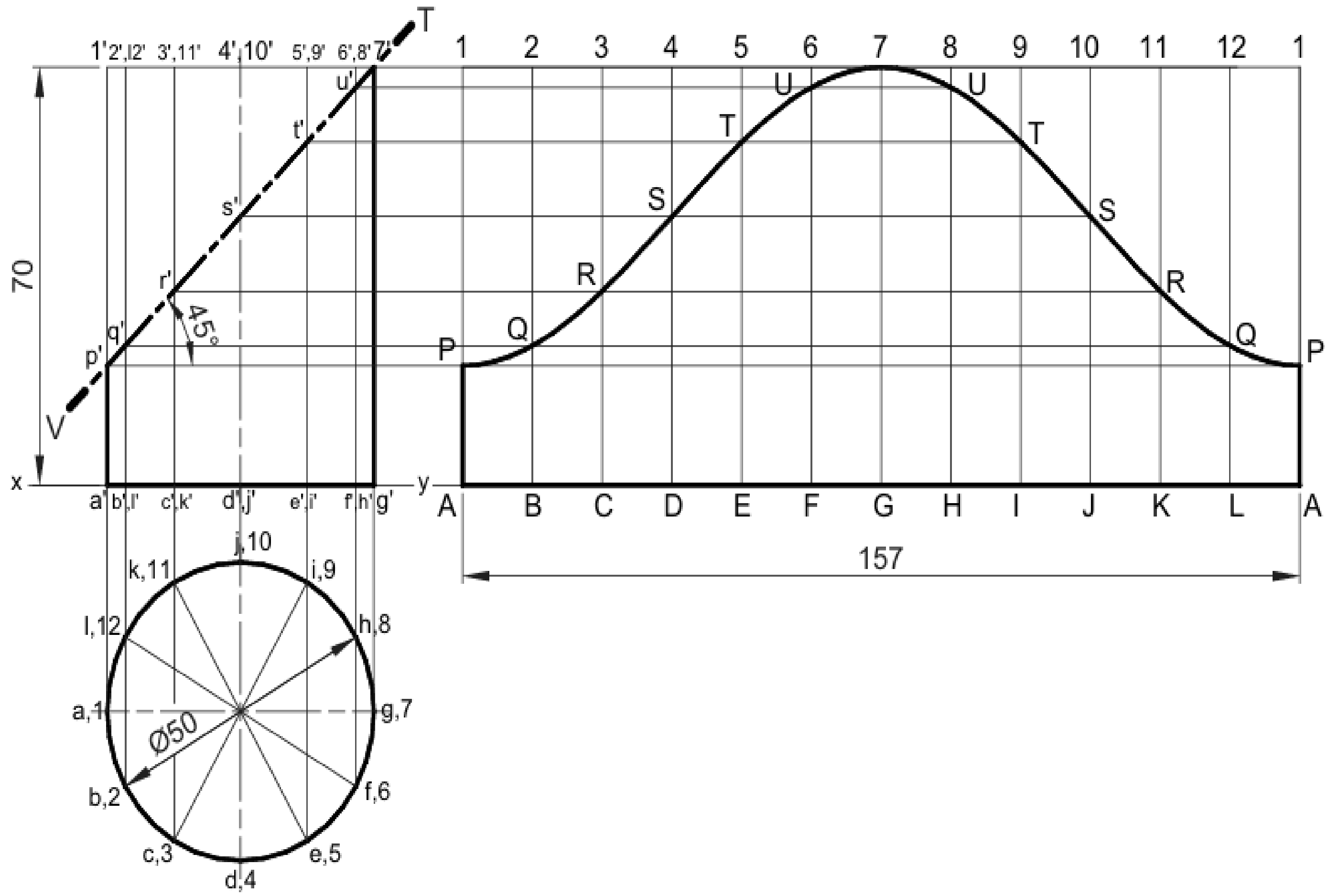
1. Projections Draw a pentagon abcde keeping de parallel to xy to represent the top view. Project all points to obtain a 'c '3 '1 ' as the front view.
2. Cutting plane Draw V.T. of the section plane inclined at 45° to xy such that it bisects the axis. Let V.T. cut the edges a '1 ' at p ', b '2 ' at q ', c '3 ' at r ', d '4 ' at s ' and e '5 ' at t '.
3. Development Consider the seam along a '1 '. Stretch out lines 1-1 and A-A from the front view equal to the perimeter of the base (150 mm). Divide 1-1 and A-A in five equal parts and name their intermediate points as 2, 3, 4, 5 and B, C, D, E respectively. Join 1A, 2B, 3C, 4D and 5E.
4. Draw horizontal lines from points p ', q ', r ', s ' and t ' to meet corresponding edges A1, B2, C3, D4 and E5 at points P, Q, R, S and T respectively. Join each of PQ, QR, RS, ST, TP with straight lines.
5. Dark the portion of the development that is retained after truncating the prism



Problem

A cylinder of base diameter 50 mm and axis 70 mm is resting on ground with its axis vertical. It is cut by a section plane perpendicular to the V.P., inclined at 45° to the H.P., passing through the top of a generator and cuts all the other generators. Draw the development of its lateral surface.

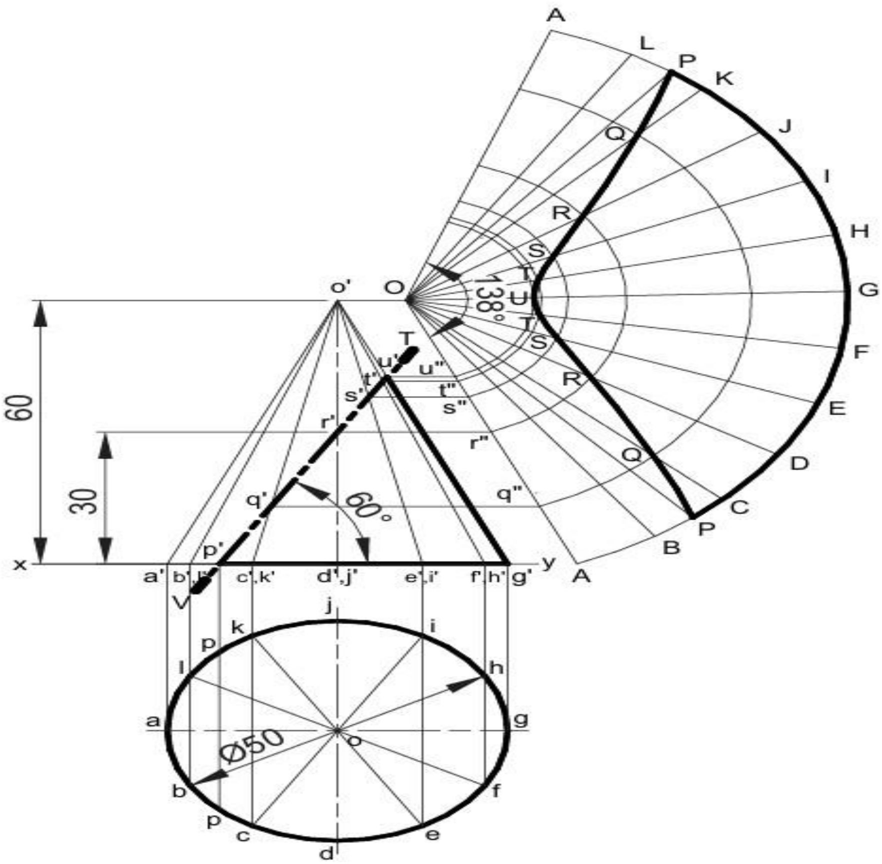
1. Projections Draw a circle adgj to represent the top view and divide it into 12 equal parts. Project all the points to obtain a 'g '7 '1 ' as the front view.
2. Cutting plane Draw V.T. of the cutting plane inclined at 45° to xy such that it passes through 7 '. Let V.T. cut the generators a '1 ' at p ', b '2 ' at q ', c '3 ' at r ', d '4 ' at s ', etc., as shown. Ø50
3. Development Consider seam at a '1 '. Stretch out lines 1-1 and A-A through the front view equal to the perimeter of the cylinder (157 mm). Divide 1-1 and A-A into 12 equal parts and join them to represent generators B2, C3, D4, E5, F6, G7, H8, I9, J10, K11 and L12. 4. 5. 6.
4. Draw horizontal lines from points p ', q ', r ', s ', etc., to meet their corresponding generators A1, B2, C3, D4, etc., at points P, Q, R, S, etc., respectively.
5. Join PQRSTU7UTSRQP with a continuous smooth curve.
6. Dark the portion of the development that is retained after truncating the cylinder.



Problem

A cone of base diameter 50 mm and axis 60 mm is resting on its base on the H.P. Draw the development of its lateral surface when it is cut by an auxiliary inclined plane inclined at 60° to the H.P. and bisecting the axis.

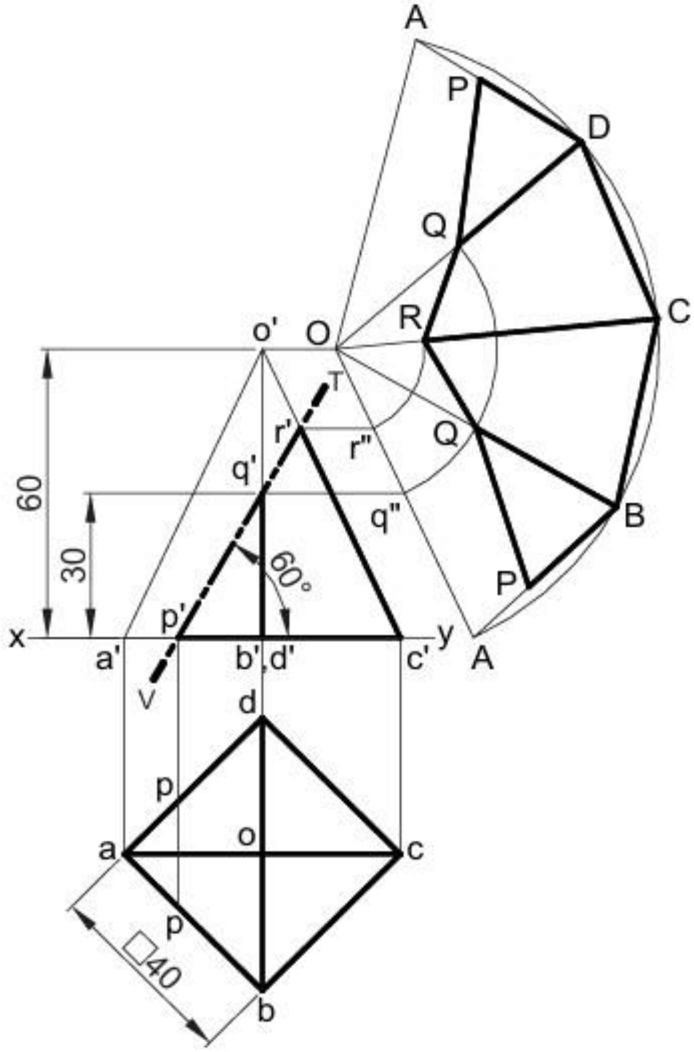
1. Draw a circle adgj as the top view and divide it into 12 equal parts. Project all the points and obtain a 'o 'g ' as the front view.
2. Draw V.T. of the cutting plane in clined at 60° to xy such that it passes through mid-point of the axis. Let V.T. cut the generators c 'o ' at q ', d 'o ' at r ', e 'o ' at s ', f 'o ' at t ', g 'o ' at u ' and base circle at p '.
3. Determine the subtended angle q as 138°. Draw a sector A-O-A with in cluded angle q. Divide the sector into 12 equal parts and mark the genera tors as OB, OC, OD,…, etc.
4. Draw the horizontal lines from points q ', r ', s ', t and u ' to meet line OA in the development at points q ≤, r ≤, s ≤, t ≤ and u ≤, respectively. Draw arcs with centre O and radii Oq ≤, Or ≤, Os ≤, Ot ≤ and Ou ≤ to meet the corresponding generators at points Q, R, S, T and U, respectively.
5. Project point p ' to meet the circle in the top view at point p. Locate point P in the development such that BP = LP = bp.
6. Join all the points obtained in the development with smooth curves. Darken the portion of the development that is retained after truncating the cone.



Problem

A square pyramid of base side 40 mm and axis 60 mm is resting on its base on the H.P. such that all the sides of the base are equally inclined to the V.P. It is cut by a section plane perpendicular to the V.P. and inclined at 60° to the H.P., bisecting the axis. Draw the development of its lateral surface.

1. Draw a square abcd keeping ab inclined at 45° to xy. Also, draw the diagonal lines of the square. This rep resents the top view. Project all the corners to obtain a 'o 'c ' as the front view.
2. Draw V.T. of the cutting plane inclined at 60° to xy such that it passes through mid-point of the axis. Let V.T. cut a 'b ' and a 'd ' at p ', o 'b ' and o 'd ' at q ', o 'c ' at r '.
3. Consider seam at o 'a '. Draw a line OA parallel and equal to o 'c '. Draw an arc with centre O and radius OA. Step off a distance of 40 mm on the arc to obtain B, C, D and A. Thus, AB = BC = CD = DA = 40 mm. Join the base sides AB, BC, CD, DA and slant edges OA, OB, OC, OD, OA.
4. Draw the horizontal lines from points q ' and r ' to meet line OA in the development at points q ≤ and r ≤, respectively. Draw arcs with centre O and radii Oq ≤ and Or ≤ to meet the corresponding generators at points Q and R, respectively.
5. Project point p ' to meet the square in the top view at point p. Locate point P in the development such that AP = ap.
6. Join PQRQP with straight lines. Darken the portion of the development that is retained after truncating the cone.


A
P
D
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C
o'
O
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T
r'
r"
Q
q'
60
30
q"
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60°
P
x
p'
y
a'
b',d'
c'
A
V
d
p
o
a
c
p
□40
b

UNIT – 5

ISOMETRIC PROJECTIONS

Isometric projection:

Isometric projection is a type of pictorial projection in which the three dimensions of a solid are not only shown in one view but their actual sizes can be measured directly from it. The three lines AL, AD and AH, meeting at point A and making 1200 angles with each other are termed Isometric Axes. The lines parallel to these axes are called Isometric Lines. The planes representing the faces of the cube as well as other planes parallel to these planes are called Isometric Planes.

Isometric scale:

When one holds the object in such a way that all three dimensions are visible then in the process all dimensions become proportionally inclined to observer's eye sight and hence appear apparent in lengths. This reduction is 0.815 or 9/11 (approx.). It forms a reducing scale which is used to draw isometric drawings and is called Isometric scale. In practice, while drawing isometric projection, it is necessary to convert true lengths into isometric lengths for measuring and marking the sizes. This is conveniently done by constructing an isometric scale as described on next page.

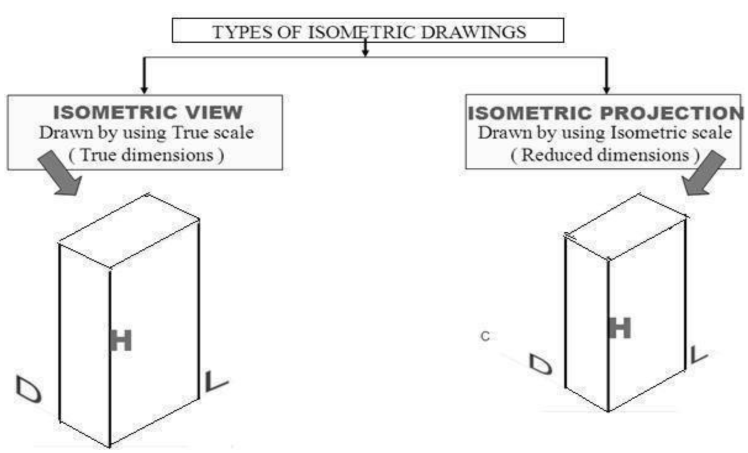
Construction of isometric scale:

From point A, with line AB draw 300 and 450 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.

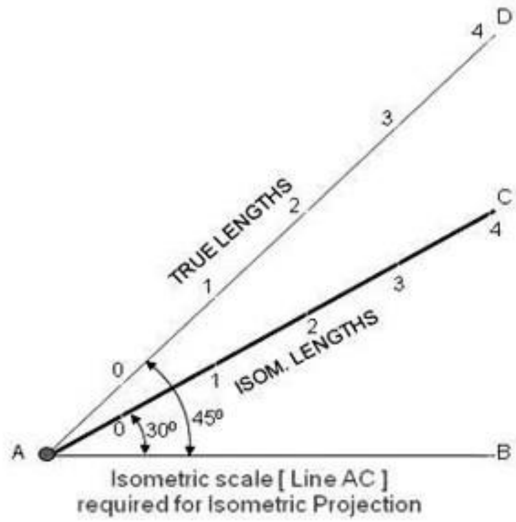
Note:

Isometric Drawing/Isometric view ⟶ true length

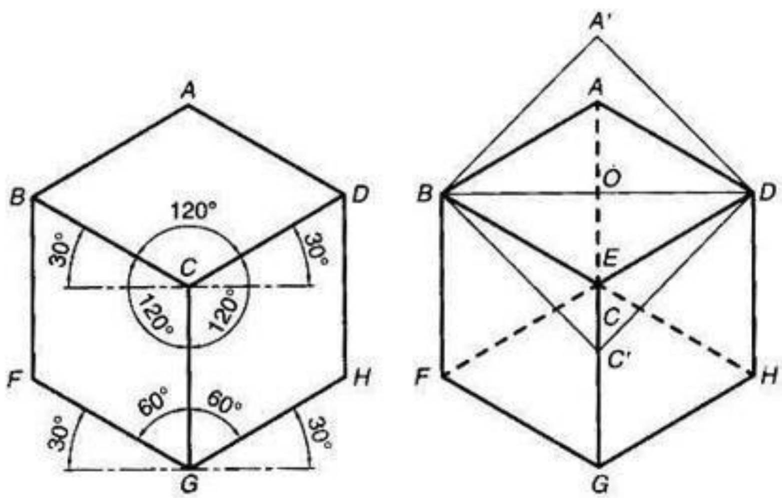
Isometric Projection ⟶ Reduced length (isometric length)



Isometric scale [Line AC] required for Isometric Projection:



Terminology:



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

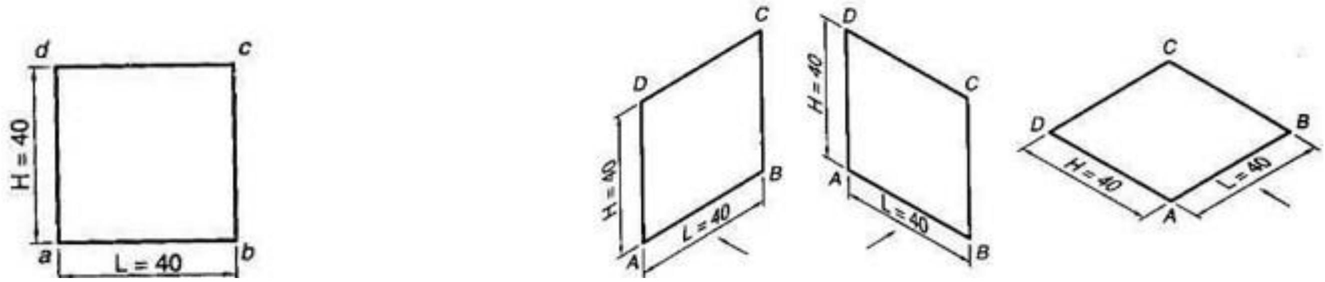
Isometric views of planes:

Simple Problems:

Problem:

Draw the isometric view of a square with 40mm side?

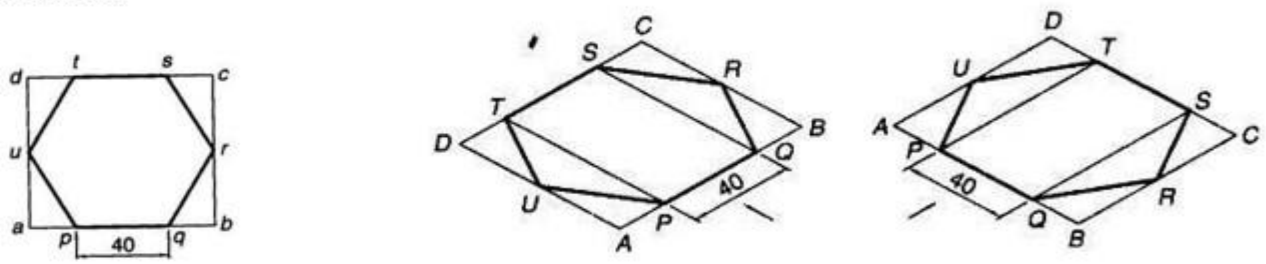
Solution:



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:



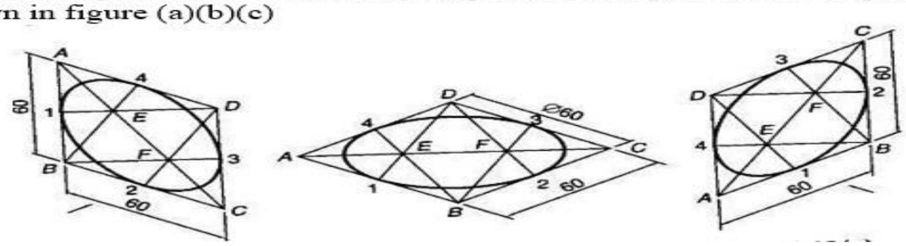
Problem:

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)



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:

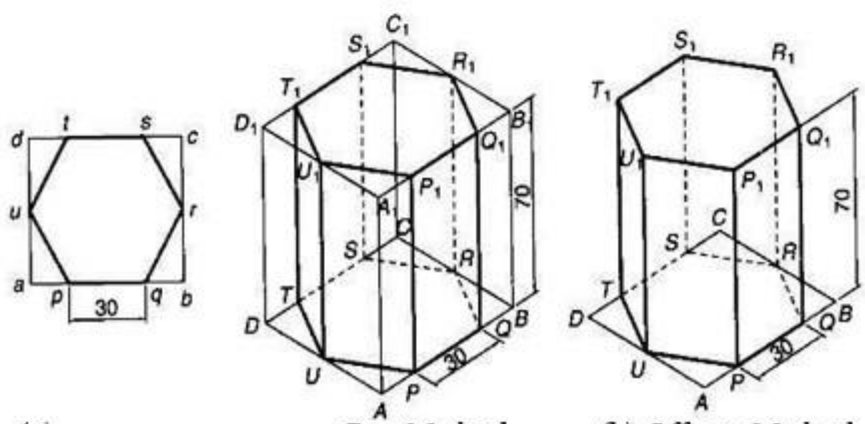
In this Off-set Method the lines parallel to isometric axes are drawn from every corner or reference of an end to obtain the corner or the reference point at the other end.

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:

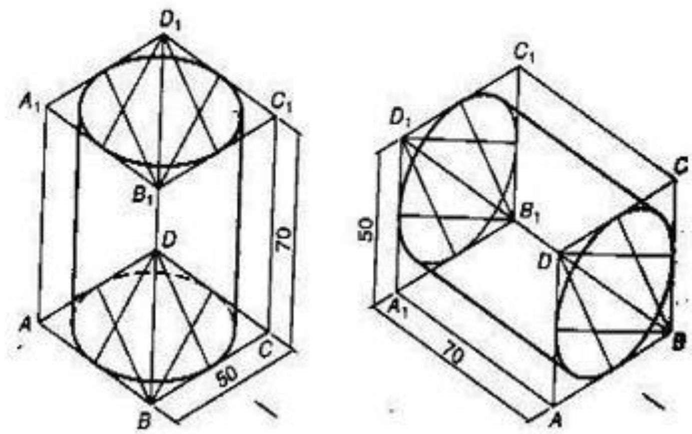


(a) *Box Method* *(b) Off-set Method*

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?

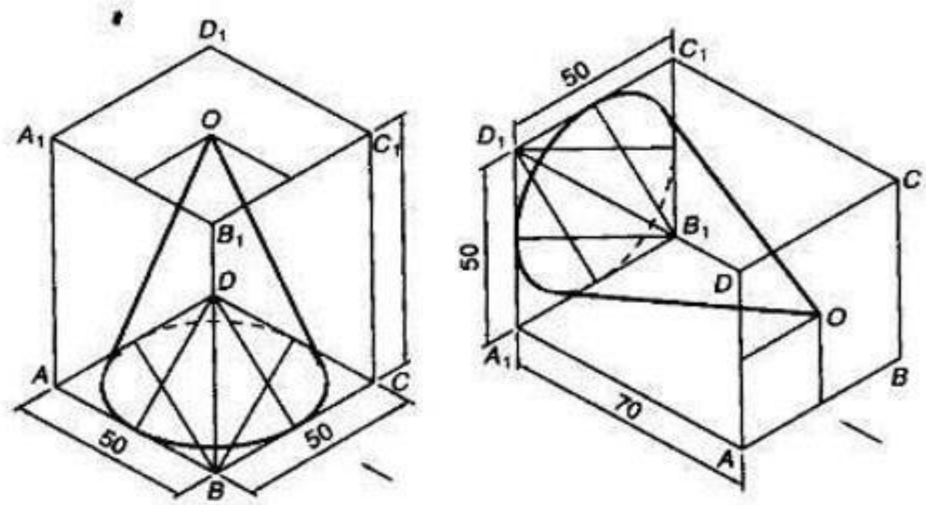
Solution:



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?

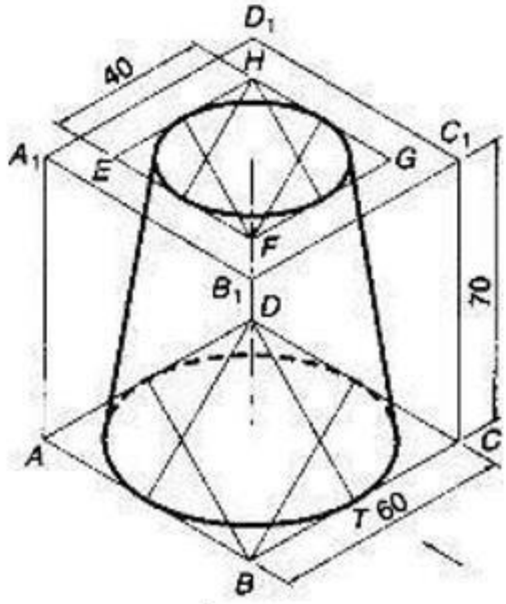
Solution:



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:



Problem:

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

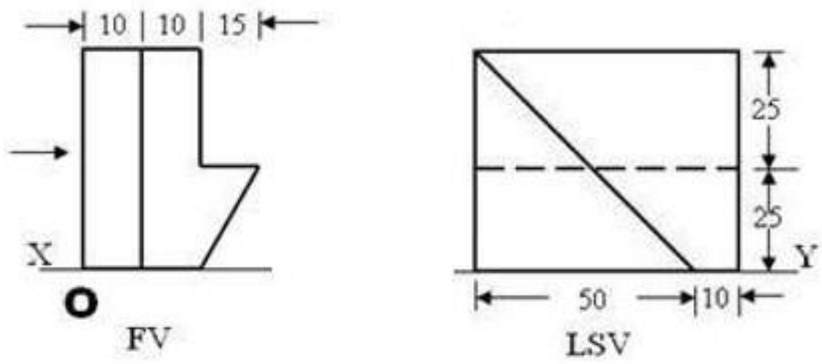
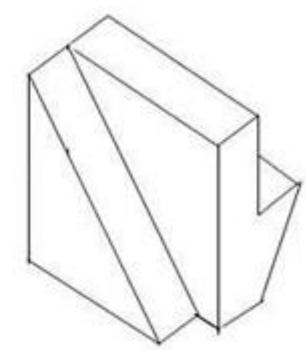


Figure 4.20(a)

Solution:



Problem:

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

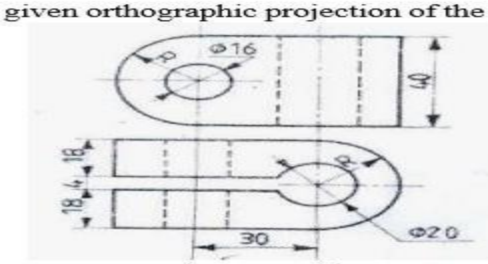


Figure 4.25(a)

Solution:

Problems:

Draw the front view, Top view and Side view of the given figure?

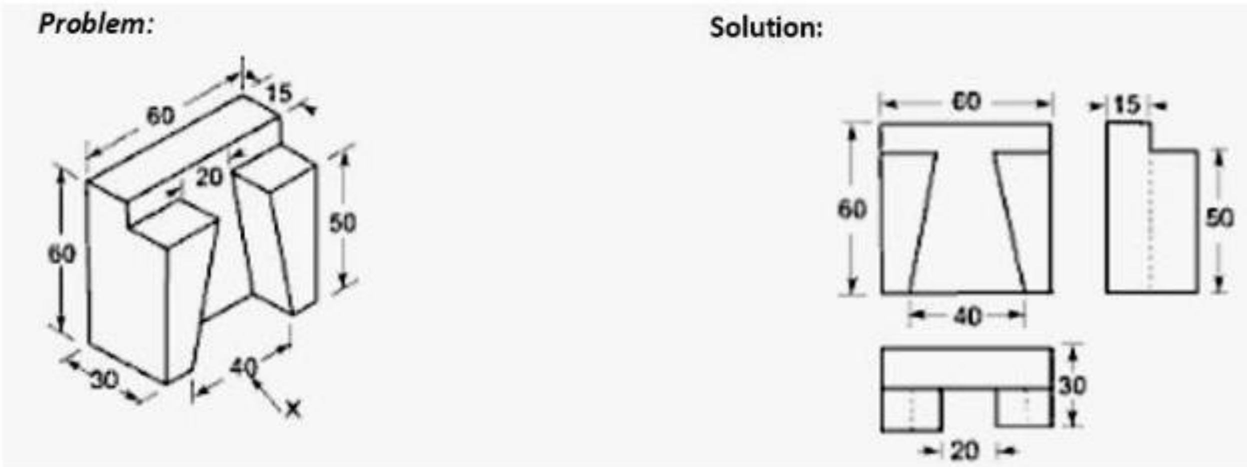
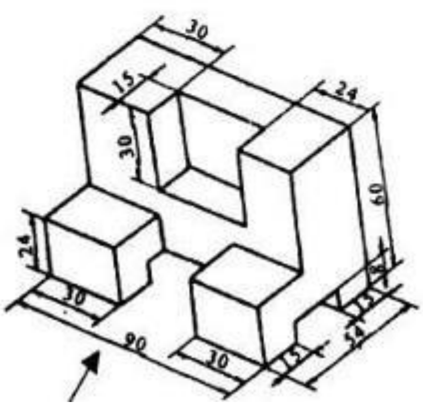
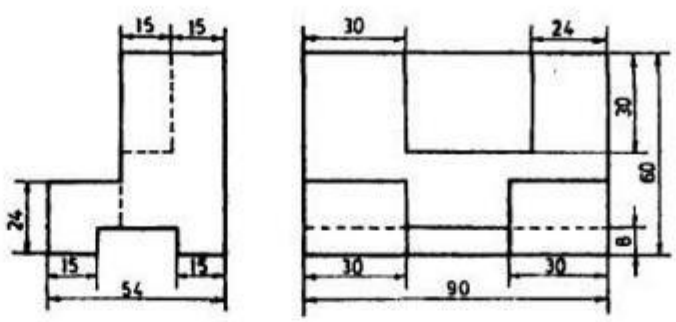


Figure 5.9

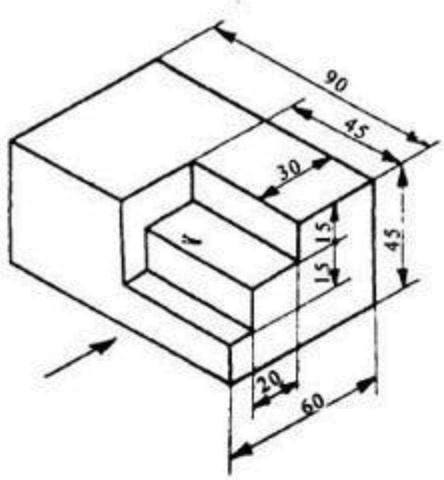
Problem:



Solution:



Problem:



Solution:

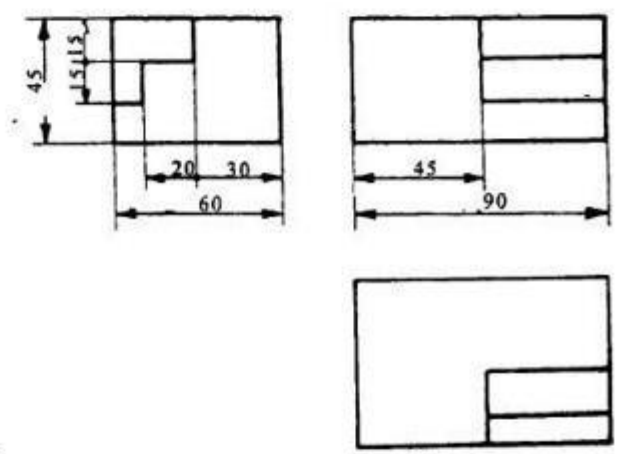
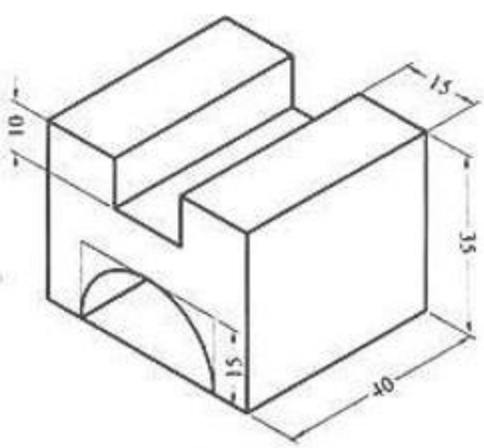


Figure 5.11

Problem



isometric view

Solution