BASED ON THE FOLLOWING SYLLABUS AND ENGINEERING DRAWING BY ND BHATT

UNIT I

Geometrical Constructions: Polygons-Construction of Regular Polygons using given length of a side; Conic sections- Ellipse- Arcs of Circles and Oblong Methods, Construction of Parabola and Hyperbola by eccentricity method only.

UNIT II

Projection of Points and Lines: Introduction to Orthographic Projections- Projections of Points-Projections of Straight Lines parallel to both planes; Projections of Straight Lines-Parallel to one and inclined to other plane, inclined to both planes, determination of true lengths, angle of inclinations.

UNIT III

Projections of Planes: Regular Planes, Plane Perpendicular to one plane and Parallel to another Reference plane, Plane inclined to one Reference Plane.

UNIT IV

Projections of Solids: Prisms, Pyramids, Cones and Cylinders with the axis perpendicular to one plane and parallel to the reference plane, Plane inclined to one reference Plane only.

UNIT V

Section of solids: Sectioning of prism, pyramid, cone and cylinder– sectional view – true shape. Solids in simple position and cutting plane inclined to one reference plane only.

Development of surface of solids: Development of truncated prism, pyramid, cone and cylinder – frustum of cone and pyramid.

UNIT VI

Orthographic and Isometric Projections: Introduction to Isometric projections/ views, Construction of Isometric view/ projections of simple solids. Conversion of Isometric Views to Orthographic Views/Projections-Conversion of Orthographic Views to Isometric Projection/ Views.

TEXT BOOK:

1) Engineering Drawing. K.L Narayana, P. Kannaiah, Scitech Publications, 2011
2) Engineering Drawing by N.D. Bhatt, Chariot Publications,2014

UNIT-I

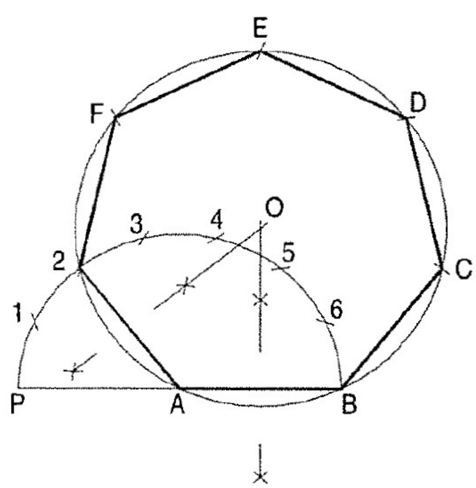
A. Regular polygons can be constructed by two methods:

1. Method – I
   a) Inscribe circle method
   b) Arc method
2. Method – II (General method)

B. Method of construction of conic sections

1. General method (or) Eccentricity method to construct ellipse, parabola and hyperbola
2. Arc of circles, Concentric circles and Oblong methods for constructing an ellipse

Inscribe circle method



(i) Draw a line *AB* equal to the given length.

(ii) With centre *A* and radius *AB,* draw a semi-circle *BP.*

(iii) With a divider, divide the semi-circle into seven equal parts (same as the number of sides). Number the division-points as 1, 2, etc. starting from *P.*

(iv) Draw a line joining *A* with the second division-point 2.

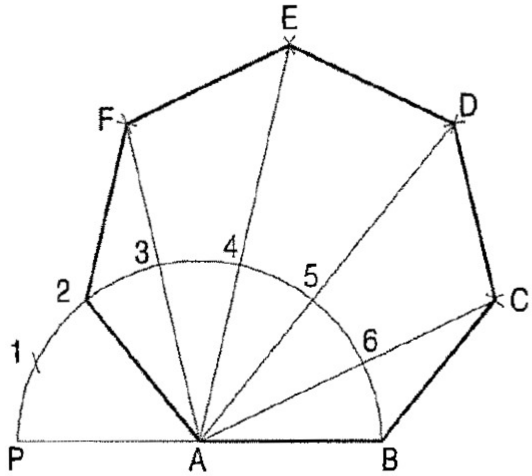
(v) Draw perpendicular bisectors of *A2* and *AB* intersecting each other at O.

(vi) With centre O and radius *OA,* describe a circle.

(vii) With radius *AB* and starting from *B,* cut the circle at points, C, *D* ..... *2.*

(viii) Draw lines *BC, CD* etc. thus completing the required heptagon.

Arc method



(i) Draw a line *AB* equal to the given length.

(ii) With centre *A* and radius *AB,* draw a semi-circle *BP.*

(iii) With a divider, divide the semi-circle into seven equal parts (same as the number of sides). Number the division-points as 1, 2, etc. starting from *P.*

(iv) Draw a line joining *A* with the second division-point 2.

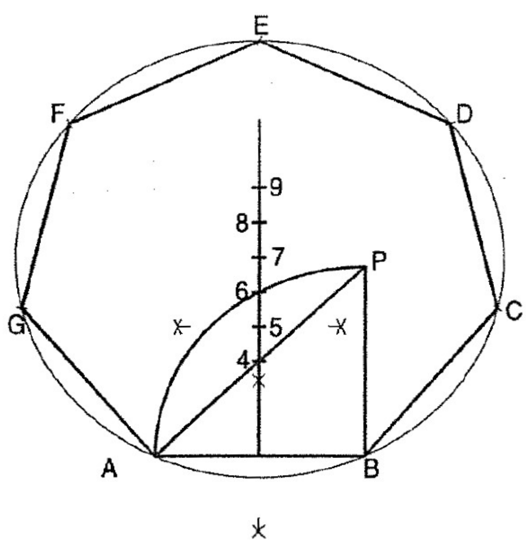
(v) With centre *B* and radius *AB,* draw an arc cutting the line A6-produced at C.

(vi) With centre C and the same radius, draw an arc cutting the line A5-produced at *D.*

(iii) Find points *E* and *F* in the same manner.

(iv) Draw lines *BC, CD* etc. and complete the heptagon.

General method



(i) Draw a line *AB* equal to the given length.

(ii) At *B,* draw a line *BP* perpendicular and equal to *AB.*

(iii) Draw a line joining *A* with *P.*

(iv) With centre *B* and radius *AB,* draw the quadrant *AP.*

(v) Draw the perpendicular bisector of *AB* to intersect the straight line *AP* in 4 and the arc *AP* in 6.

(a) A ***square*** of a side equal to *AB* can be inscribed in the circle drawn with centre 4 and radius *A4.*

(b) A regular ***hexagon*** of a side equal to *AB* can be inscribed in the circle drawn with centre 6 and radius *A6.*

(c) The mid-point 5 of the line 4-6 is the centre of the circle of the radius *A5* in which a regular ***pentagon*** of a side equal to *AB* can be inscribed.

(d) To locate centre 7 for the regular ***heptagon*** of side *AB,* step-off a division 6-7 equal to the division 5-6.

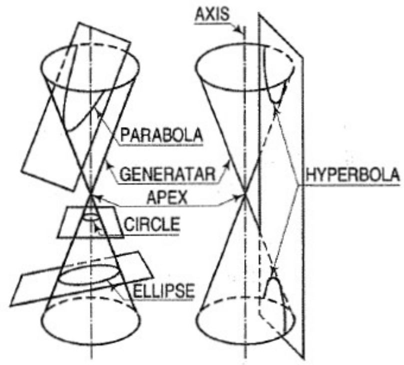
(i) With centre 7 and radius equal to *A7,* draw a circle.

(ii) Starting from *B,* cut it in seven equal divisions with radius equal to *AB.*

(iii) Draw lines *BC, CD* etc. and complete the heptagon.

Regular polygons of any number of sides can be drawn by this method.

- The sections obtained by the intersection of the right circular cone by a plane in different positions relative to the axis of the cone are called **CONICS**.
- When the section plane is inclined to the axis and cuts all the generators on one side of the apex, the section is an *ellipse.*
- When the section plane is inclined to the axis and is parallel to one of the generators, the section is a *parabola .*
- A *hyperbola* is a plane curve having two separate parts or branches, formed when two cones that point towards one another are intersected by a plane that is parallel to the axes of the cones.



Conic sections

- The conic may be defined as the locus of a point moving in a plane in such a way that the ratio of its distances from a fixed point and a fixed straight line is always constant. The fixed point is called the *focus* and the fixed line, the *directrix.*
- The ratio between distance of the point from the focus and distance of the point from the directrix is called *eccentricity* and is denoted by *e*. It is always less than 1 for ellipse, equal to 1 for parabola and greater than 1 for hyperbola i.e.
  - ellipse: $e < 1$
  - Parabola: $e = 1$
  - Hyperbola: $e > 1$
- The line passing through the focus and perpendicular to the directrix is called the *axis*. The point at which the conic cuts its axis is called the *vertex*.

1. ELLIPSE

A. General method of construction of an ellipse:

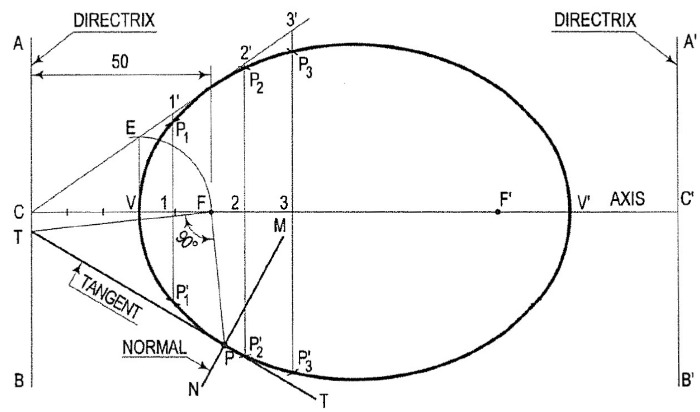
1. *To construct an ellipse when the distance of the focus from the directrix* is *equal to 50 mm and eccentricity is 2/3·*

(i) Draw any vertical line *AB* as directrix.

(ii) At any point C on it, draw the axis perpendicular to the *AB* (directrix).

(iii) Mark a focus *F* on the axis such that $CF = 50\ mm.$

(iv) Divide CF into 5 equal divisions (sum of numerator and denometer of the eccentricity.).



Directrix and focus

(v) Mark the vertex *V* on the third division-point from C. Thus, eccentricity, $e = VF/VC = 2/3$

(vi) At *V,* draw a perpendicular *VE* equal to *VF.* Draw a line joining C and *E. Thus, in triangle CVE,* $VE/VC = VF/VC = 2/3$

(vii) Mark any point 1 on the axis and through it, draw a perpendicular to meet CE-produced at 1 ‘.

(viii) With centre *F* and radius equal to 1-1 ', draw arcs to intersect the perpendicular through 1 at points P_1 and P'_1.

(ix) These are the points on the ellipse, because the distance of P_1 from *AB* is equal to C1,

$$P_1F = 1\text{-}1'$$

and
$$\frac{1-1'}{C1} = \frac{VF}{VC} = \frac{2}{3}.$$

(x) Similarly, mark points 2, 3 etc. on the axis and obtain points P_2 and P'_2, P_3 and P'_3 etc.

(x) Draw the ellipse through these points. It is a closed curve having two foci and two directrices.

To construct an ellipse, given the major and minor axes.

1. Arc of Circles method

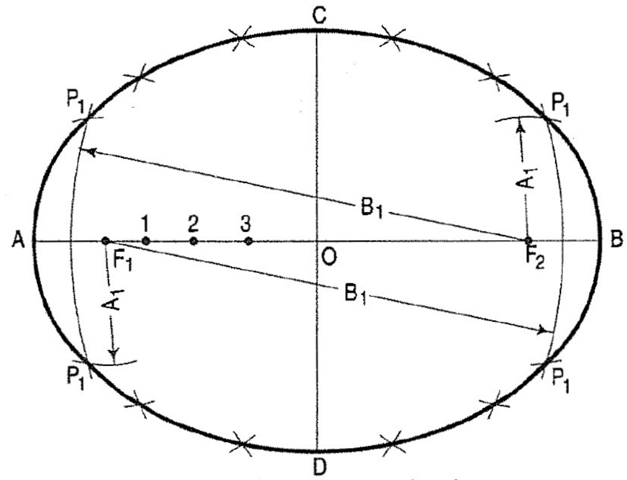
(i) Draw a line AB equal to the major axis and a line CD equal to the minor axis, bisecting each other at right angles at O.

(ii) With centre C and radius equal to half AB (i.e. AO) draw arcs cutting AB at F_1 and F_2, the foci of the ellipse.

(iii) Mark a number of points 1, 2, 3 etc. on AB.

(iv) With centres F_1 and F_2 and radius equal to A1, draw arcs on both sides of AB.

(v) With same centres and radius equal to B1, draw arcs intersecting the previous arcs at four points marked P_1.



Arc of circle method

(vi) Similarly, with radii *A2* and B2, *A3* and *B3* etc. obtain more points.

(vii) Draw a smooth curve through these points. This curve is the required ellipse.

2. Concentric circles method

(i) Draw the major axis *AB* and the minor axis *CD* intersecting each other at O.

(ii) With centre O and diameters *AB* and *CD* respectively, draw two circles.

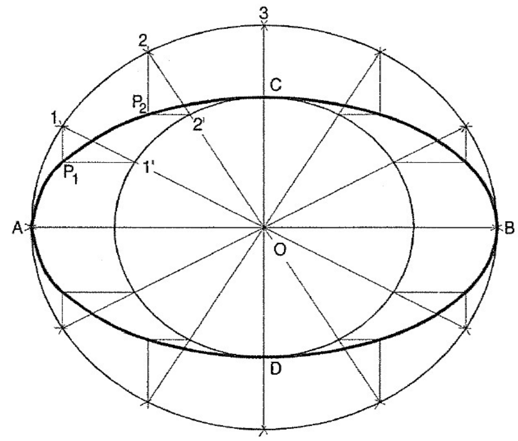
(iii) Divide the major-axis-circle into a number of equal divisions, say 12 and mark points 1, 2 etc. as shown.

(iv) Draw lines joining these points with the centre O and cutting the minor-axis-circle at points 1 ', 2' etc.

(v) Through point 1 on the major-axis-circle, draw a line parallel to *CD,* the minor axis.

(vi) Through point 1' on the minor-axis-circle, draw a line parallel to *AB,* the major axis. The point P_1, where these two lines intersect is on the required ellipse.

(vii) Repeat the construction through all the points. Draw the ellipse through *A,* P_1, *P2* .... etc.



Concentric circle method

3. Oblong method

(i) Draw the two axes *AB* and *CD* intersecting each other at O.

(ii) Construct the oblong *EFGH* having its sides equal to the two axes.

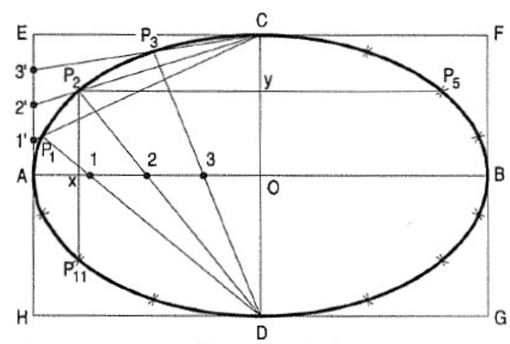
(iii) Divide the semi-major-axis *AO* into a number of equal parts, say 4, and *AE* into the same number of equal parts, numbering them from *A* as shown.

(iv) Draw lines joining 1 ', 2' and 3' with C.

(v) From *D,* draw lines through 1, 2 and 3 intersecting C'1, C'2 and C'3 at points P_1, P_2 and P_3 respectively.

(vi) Draw the curve through *A,* P_1 ..... C. It will be one quarter of the ellipse.

(vii) Complete the curve by the same construction in each of the three remaining quadrants.



Oblong method

2. PARABOLA

General method of construction of a parabola:

To construct a parabola, when the distance of the Focus from the directrix is 50 mm.

(i) Draw the directrix *AB* and the axis *CD.*

(ii) Mark focus *F on CD,* 50 mm from C.

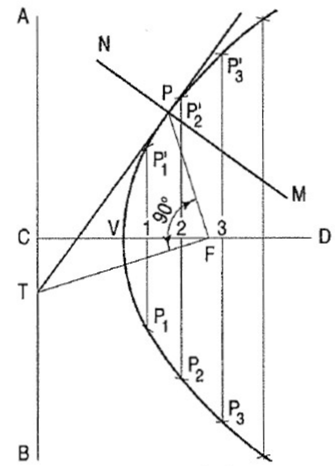
(iii) Bisect *CF* in *V* the vertex (because eccentricity = 1).

(iv) Mark a number of points 1, 2, 3 etc. on the axis and through them, draw perpendiculars to it.

(v) With centre *F* and radius equal to C1, draw arcs cutting the perpendicular through 1 at P_1 and P'_1 .

(vi) Similarly, locate points P_2 and P'_2 , P_3 and P'_3 etc. on both the sides of the axis.

(vii) Draw a smooth curve through these points. This curve is the required parabola. It is an open curve.



Directrix and focus

3. HYPERBOLA

Construct a hyperbola, when the distance of the focus from the directrix is 65 mm and eccentricity is $3/2$

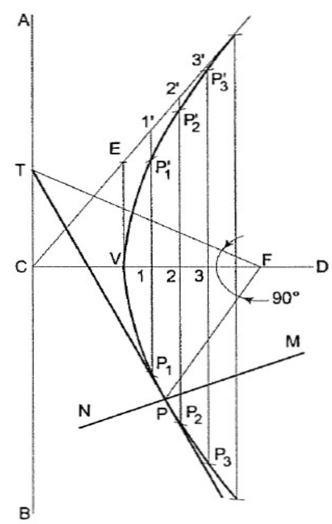
(i) Draw the directrix *AB* and the axis *CD.*

(ii) Mark the focus *F* on *CD* and 65 mm from C.

(iii) Divide *CF* into 5 equal divisions and mark *V* the vertex, on *the second division from* C. Thus, $eccentricity = VF/VC = 3/2$

To construct the scale for the ratio 3/2 draw a line *VE* perpendicular to *CD* such that *VE* = *VF.* Join C with *E.*

Thus, in triangle CVE, $\frac{VE}{VC} = \frac{VF}{VC} = \frac{3}{2}$.



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

(v) With centre F and radius equal to 1-1 ', draw arcs intersecting the perpendicular through 1 at P_1 and P'_1·

(vi) Similarly, mark a number of points 2, 3 etc. and obtain points P_2 and P'_2, P_3 and P'_3 etc.

(vii) Draw the hyperbola through these points.

Assignment problems

1. Two points A and B are located on a plane sheet of paper and are 100 mm apart. A point P moves on the sheet such that difference of its distance from A and B always remain constant and is 50 mm. Find the locus of P and name curve.
2. Construct a regular polygon of 5, 6 & 7 sides with the length of the side as 35 mm by general method, arc method and inscribed circle method.
3. The major and minor axes of an ellipse are 160 mm and 90 mm respectively. Find the foci and draw the ellipse by concentric circles method. Draw a normal and Tangent to the ellipse at a point 35 mm above the major axis.
4. The major and minor axes of an ellipse are 170 mm and 100 mm respectively. Draw the ellipse by oblong method.
5. Mark points A and B 50 mm apart, mark a third point 75 mm from both A and B. Describe a circle passing the three points.
6. The major-axis AB of an ellipse is 140 mm long with P as its mid-point. The foci F_1 and F_2 of the ellipse are 48 mm away from the midpoint P. Draw the ellipse and find the length of the minor axis.
7. Construct an ellipse when the distance of the focus from the directrix is equal to 50 mm and eccentricity is 2/3·
8. A fixed point is 75 mm from a fixed straight line. Draw the locus of a point P moving such a way that its distance from the fixed straight line is (i) twice its distance from the fixed point; (ii) equal to its distance from the fixed point. Name the curves.

UNIT-II

1. Introduction to orthographic projections
2. Projection of points
3. Projection of straight lines
    A. Perpendicular to one plane and parallel to other
    B. Parallel to both HP and VP
    C. Inclined to HP and Parallel to VP
    D. Inclined to VP and parallel to HP
    E. Line inclined to both HP and VP.

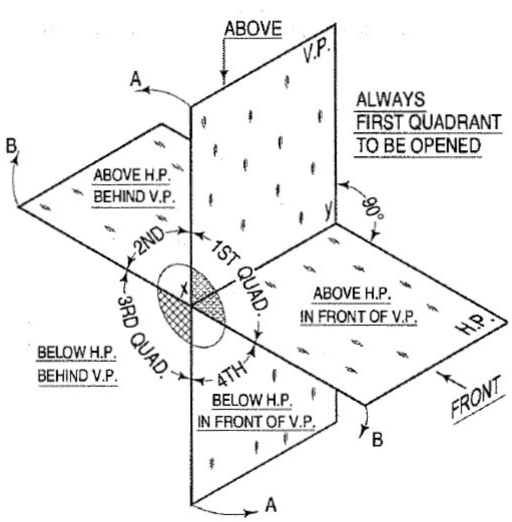
Principle of projection

- If straight lines are drawn from various points on the contour of an object to meet a plane, the object is said to be projected on that plane. The figure formed by joining, in correct sequence, the points at which these lines meet the plane, is called the *projection* of the object. The lines from the object to the plane are called *projectors.*
- In engineering drawing following *four* methods of projection are commonly used, they are:
    (1) Orthographic projection
    (2) Isometric projection
    (3) Oblique projection
    (4) Perspective projection.
- When the projectors are parallel to each other and also perpendicular to the plane, the projection is called *orthographic projection*

Planes of projection

- The two planes employed for the purpose of orthographic projections are called *reference planes or principal planes of projection.*
- They intersect each other at right angles. The *vertical plane* of projection (in front of the observer) is usually denoted by the letters V.P. It is often called the *frontal plane* and denoted by the letters F.P.
- The other plane is the *horizontal plane* of projection known as the H.P. The line in which they intersect is termed the *reference line* and is denoted by the letters *xy.*
- The projection on the V.P. is called the *front view* or the *elevation* of the object. The projection on the H.P. is called the *top view* or the *plan*.

- When the object situated in front of the V.P. and above the H.P. i.e. in the first quadrant and then projected it on these planes. This method of projection is known as *first-angle projection method.* The object lies between the observer and the plane of projection. In this method, when the views are drawn in their relative positions, the top view comes below the front view.
- When the object is assumed to be situated in the third quadrant , the planes of projection are assumed to be transparent. They lie between the object and the observer. When the observer views the object from the front, the rays of sight intersect the V.P. The figure formed by joining the points of intersection in correct sequence is the front view of the object.

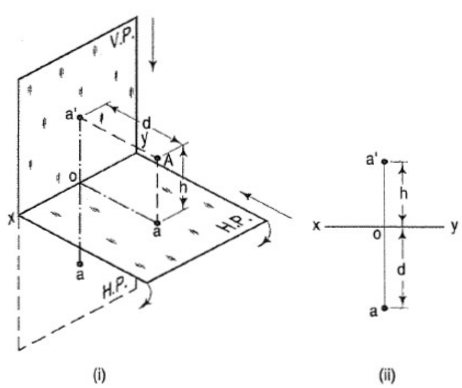


S.No	First-angle Projection method	Third-angle Projection method
1.	The object is kept in the *first quadrant.*	The object is assumed to be kept in the *third quadrant.*
2.	The object .lies between the observer and the plane of projection.	The plane of projection lies between the observer and the object.
3.	The plane of projection is assumed to be non-transparent.	The plane of projection is assumed to be *transparent.*
4.	In this method, when the views are drawn in their relative positions,· the *plan* comes *below* the *elevation,* the view of the object as observed from the *left-side* is drawn to the *right of elevation.*	In this method, when the views are drawn in their relative positions, the *plan,* comes *above* the elevation, *left hand side view* is drawn to the *left hand side* of *the elevation.*
5.	This method of projection is now recommended by the "Bureau of Indian Standards' from 1991.	This method of projection is used in U.S.A. and also in other countries;

PROJECTION OF POINTS

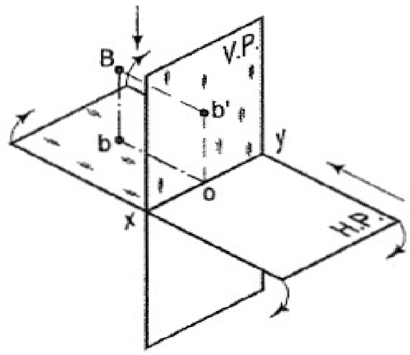
- A point may be situated, in space, in any one of the four quadrants formed by the two principal planes of projection or may lie in any one or both of them. Its projections are obtained by extending projectors perpendicular to the planes.

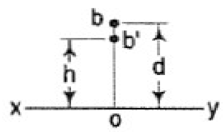
<u>A point is situated in the first quadrant</u>



The front view a' is above xy and the top view a below it. The line joining a' and a (which also is called a projector), intersects xy at right angles at a point o.

A point is situated in the second quadrant

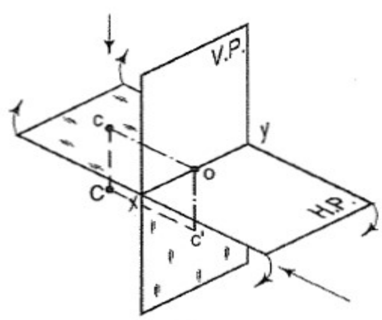


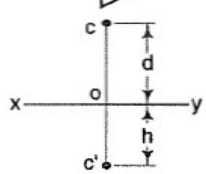


A point B is above the H.P. and behind the V.P., i.e. in the second quadrant. b' is the front view and b the top view.

When the planes are rotated, both the views are seen above *xy*. Note that $b'o = Bb$ and $bo = Bb'$.

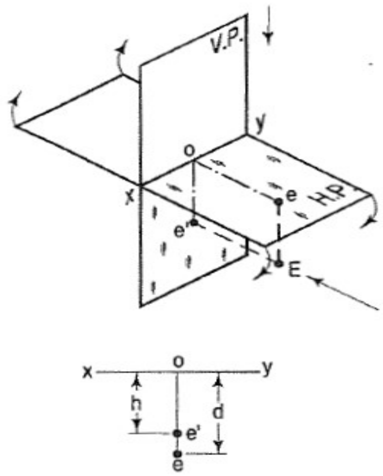
A point is situated in the third quadrant





A point C is below the H.P. and behind the V.P., i.e. in the third quadrant. Its front view c' is below *xy* and the top view c above *xy*. Also $c'o = Cc$ and $co = Cc'$.

A point is situated in the fourth quadrant



A point E is below the H.P. and in front of the V.P., i.e. in the fourth quadrant. Both its projections are below *xy*, and $e'o = Ee$ and $eo = Ee'$.

General Conclusions

(i) The line joining the top view and the front view of a point is always perpendicular to *xy*. It is called a *projector*.

(ii) When a point is above the H.P., its front view is above *xy;* when it is below the H.P., the front view is below *xy*. The distance of a point from the H.P. is shown by the length of the projector from its front view to *xy*, e.g. *a'o, b'o* etc.

(iii) When a point is in front of the V.P., its top view is below *xy;* when it is behind the V.P., the top view is above *xy*. The distance of a point from the V.P. is shown by the length of the projector from its top view to *xy*, e.g. *ao, bo* etc.

(iv) When a point is in a reference plane, its projection on the other reference plane is in *xy*.

1. A point P is in the first quadrant. Its shortest distance from the intersection point of H.P., V.P. and Auxiliary vertical plane, perpendicular to the H.P. and V.P. is 70 mm and it is equidistant from principal planes (H.P. and V.P.). Draw the projections of the point and determine its distance from the H.P. and V.P.

Note: O represents intersection of H.P., V.P. and A.V.P.

(i) Draw *xy* and x_1 y_1 perpendicular reference lines.

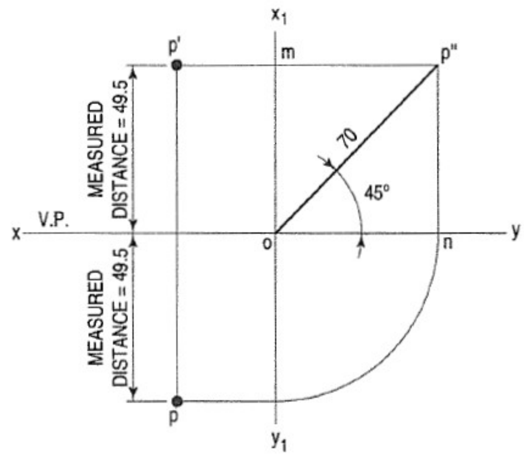
(ii) O represents intersection of H.P., V.P. and A.V.P.

(iii) Draw from O a line inclined at 45° of 70 mm length.

(iv) Project from *P″* on *xy* line and x_1 y_1 . The projections are *n* and *m* respectively as shown in figure. From O draw arc intersecting x_1 y_1.

(v) Draw a parallel line at convenient distance from x_1 y_1 . Extend *P″m* to intersect a parallel line at *p′* and *p* as shown.

(vi) Measure distance from *xy* line, which is nearly 49.4974 mm say 49.5 mm.



Exercise Problems

1. Draw the projections of the following points on the same ground line, keeping the projectors 25 mm apart.

   (i) A, in the H.P. and 20 mm behind the V.P.

   (ii) B, 40 mm above the H.P. and 25 mm in front of the V.P.

   (iii) C, in the V.P. and 40 mm above the H.P.

   (iv) D,25 mm below the H.P. and 25 mm behind the V.P.

   (v) E, 15 mm above the H.P. and 50 mm behind the V.P.

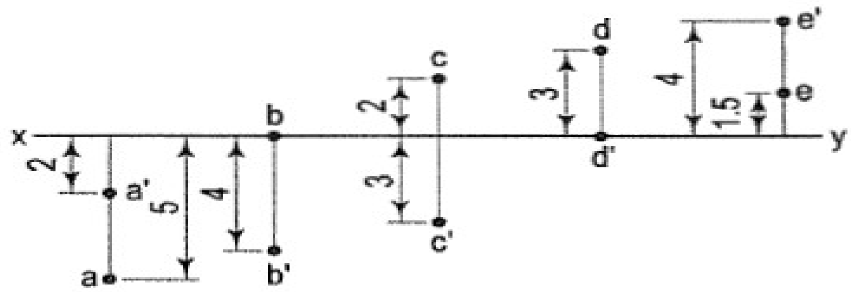
   (vi) F, 40 mm below the H.P. and 25 mm in front of the V.P.

   (vii) G, in both the H.P. and the V.P.

2. A point *P* is 50 mm from both the reference planes. Draw its projections in all possible positions.

3. A point P is 15 mm above the H.P. and 20 mm in front of the V.P. Another point Q is 25 mm behind the V.P. and 40 mm below the H.P. Draw projections of P and Q keeping the distance between their projectors equal to 90 mm. Draw straight lines joining (i) their top views and (ii) their front views.

4. Projections of various points are given in figure. State the position of each point with respect to the planes of projection, giving the distances in centimetres.



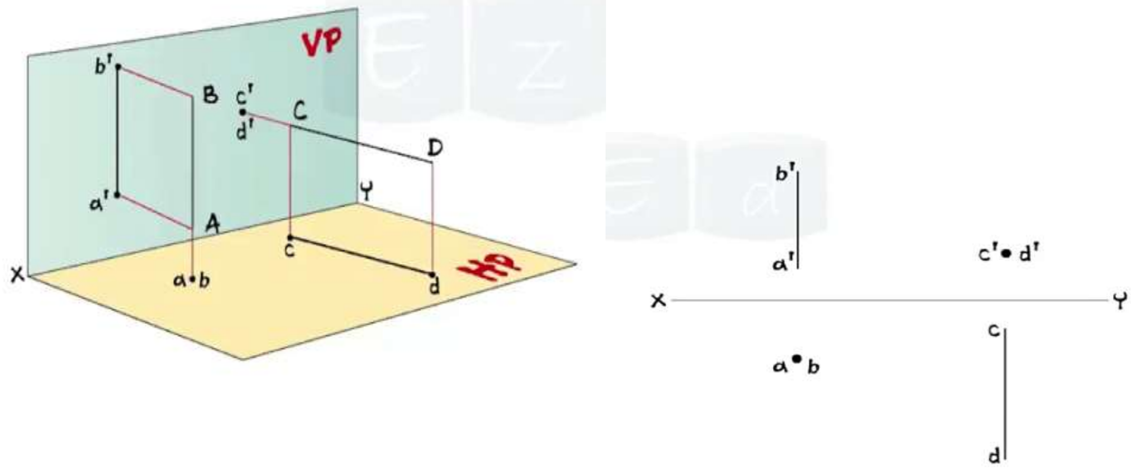
PROJECTION OF STRAIGHT LINES

1. Perpendicular to one plane and parallel to other

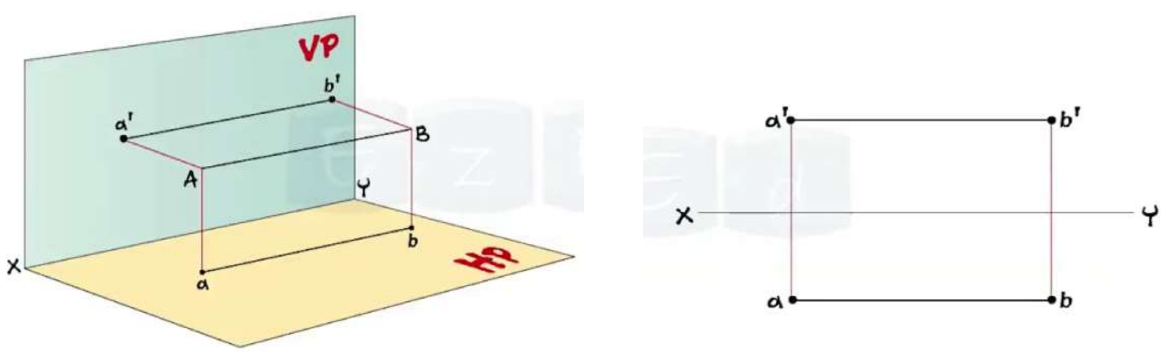
(a) Line AB is perpendicular to the H.P. The top views of its ends coincide in the point a. Hence, the top view of the line AB is the point a. Its front view $a'b'$ is equal to AB and perpendicular to xy.

(b) Line CD is perpendicular to the V.P. The point d' is its front view and the line cd is the top view. cd is equal to CD and perpendicular to xy.

Hence, when a line is perpendicular to a plane its projection on that plane is a point; while its projection on the other plane is a line equal to its true length and perpendicular to the reference line.

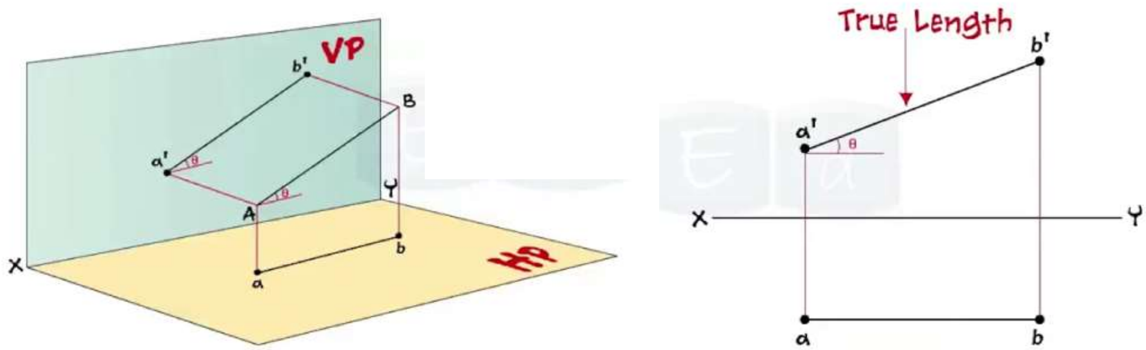


2. Parallel to both HP and VP



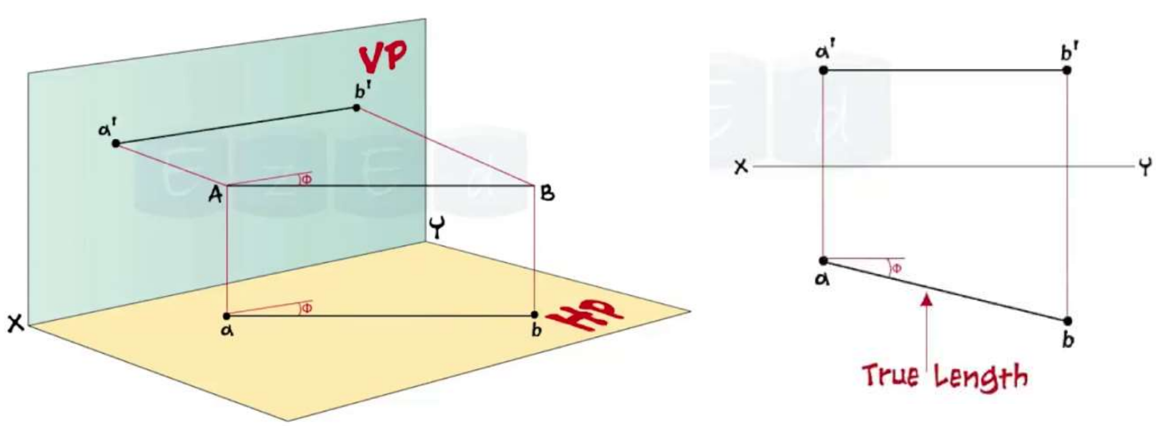
ab is the top view and a'b' is the front view; both are equal to AB and parallel to xy.

3. Inclined to HP and Parallel to VP



Dr. Abhishek Dasore 35

4. Inclined to VP and Parallel to HP



Dr. Abhishek Dasore 36

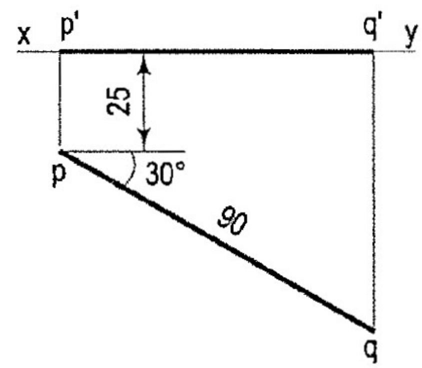
Problems

1. A line PQ, 90 mm long, is in the H.P. and makes an angle of 30° with the V.P. Its end P is 25 mm in front of the V.P. Draw its projections.

As the line is in the H.P., its top view will show the true length and the true inclination with the V.P. Its front view will be in xy.

(i) Mark a point *p,* the top view 25 mm below *xy.* Draw a line *pq* equal to 90 mm and inclined at 30° to *xy.*

(ii) Project *p* to *p′* and *q* to *q′* on *xy. pq* and *p′q′* are the required top view and front view respectively.



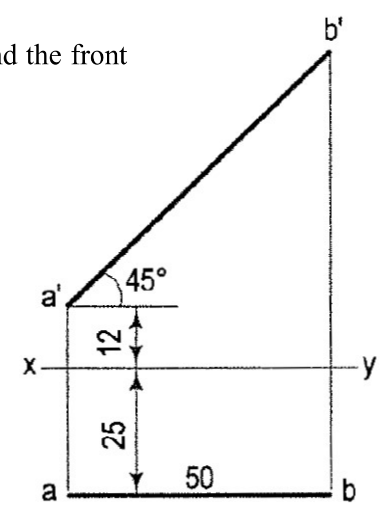
2. The length of the top view of a line parallel to the V.P. and inclined at 45° to the H.P. is 50 mm. One end of the line is 12 mm above the H.P. and 25 mm in front of the V.P. Draw the projections of the line and determine its true length.

As the line is parallel to the V.P., its top view will be parallel to *xy* and the front view will show its true length and the true inclination with the H.P.

(i) Mark *a,* the top view, 25 mm below *xy* and a’, the front view, 12 mm above *xy.*

(ii) Draw the top view *ab* 50 mm long and parallel to *xy* and draw a projector through *b.*

(iii) From *a′* draw a line making 45° angle with *xy* and cutting the projector through *b* at *b′*. Then *a′b′* is the front view and also the true length of the line.

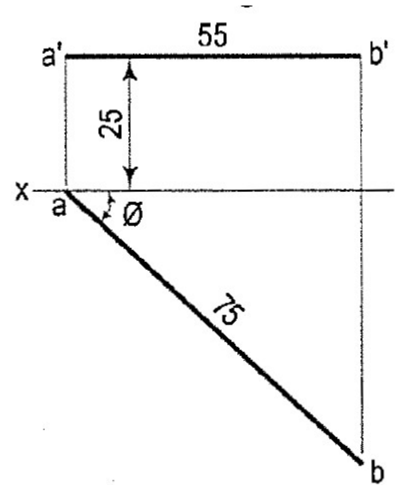


3. The front view of a 75 mm long line measures 55 mm. The line is parallel to the H.P. and one of its ends is in the V.P. and 25 mm above the H.P. Draw the projections of the line and determine its inclination with the V.P.

As the line is parallel to the H.P., its front view will be parallel to *xy*.

(i) Mark *a,* the top view of one end in *xy,* and a', its front view, 25 mm above *xy.*

(ii) Draw the front view *a'b',* 55 mm long and parallel to *xy.* With *a* as centre and radius equal to 75 mm, draw an arc cutting the projector through b' at *b*. Join a with *b*. *ab* is the top view of the line. Its inclination with *xy,* viz. Ø is the inclination of the line with the V.P.



5. Inclined to both VP and HP

(i) Draw the projections $a'b_1'$and ab_2 making an angle θ and $\emptyset$ respectively with xy, after location of the projections $a'$and a from the given position of the end point A.

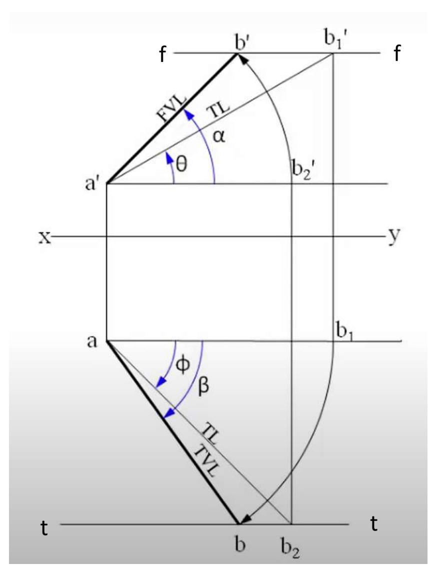
(ii) Obtain the projections $a'b_2'$and ab_1 , parallel to xy, by rotation.

(iii) Draw the lines f-f and t-t the loci parallel to xy and passing through $b_1'$and b_2 respectively.

(iv) With centre $a'$and $a'b_2'$, draw an arc meeting f-f at b'

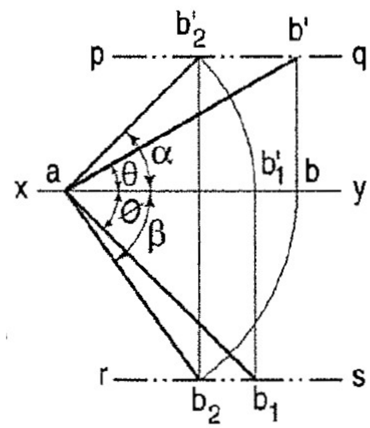
(v) With centre a and radius ab_1 , draw an arc meeting t-t at b.

(vi) Join $a'b'$and ab forming the required final projections. It is observed from the figure

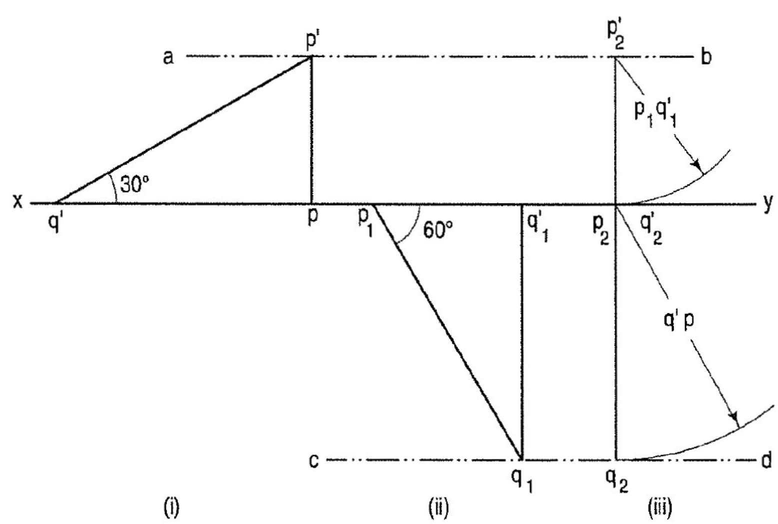


Examples

1. A line AB, 50 mm long, has its end A in both the H.P. and the V.P. It is inclined at 30° to the H.P. and at 45° to the V.P. Draw its projections



2. A line PQ 75 mm long, has its end P in the V.P. and the end Q in the H.P. The line is inclined at 30° to the H.P. and at 60° to the V.P. Draw its projections.



The top view of P and the front view of Q will be in xy.

(i) the length of PQ in the top view, viz. $q'p$ and the path ab of the end P in the front view;

(ii) the length $p_1q'_1$ in the front view and the path cd of the end Q in the top view.

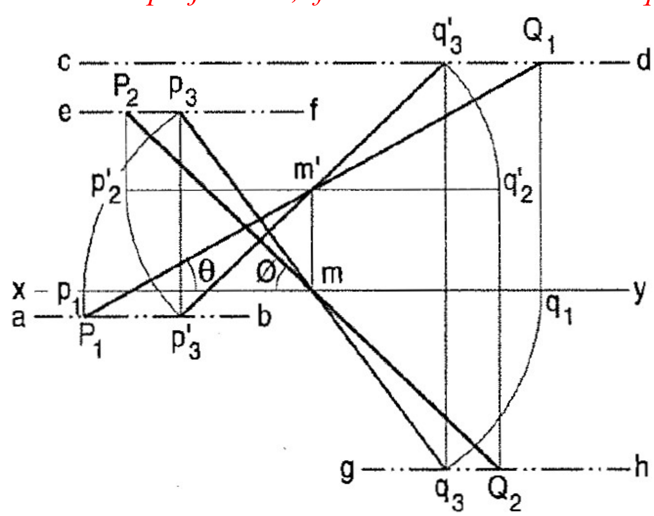
(iii) Mark any point p_2 (the top view of P) in xy and project its front view p'_2 in ab.

(iv) With p'_2 as centre and radius equal to $p_1q'_1$, draw an arc cutting xy in q'_2. It coincides with p_2.

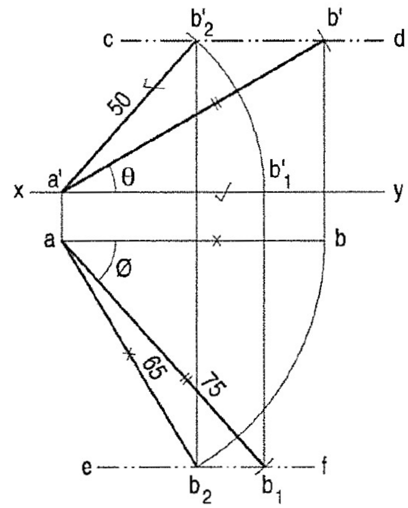
(v) With p_2 as centre and radius equal to $q'p$, draw an arc cutting cd in q_2.

p_2q_2 and $p'_2q'_2$ are the required projections. They lie in a line perpendicular to xy because the sum of the two inclinations is equal to 90°.

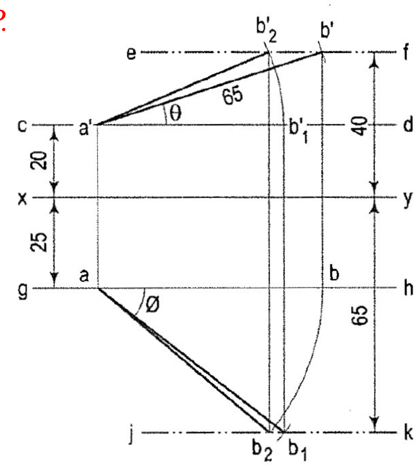
3. A fine PQ 100 mm long, is *inclined at* 30° *to the H.P. and at 45° to the V.P. Its mid-point is in the V.P. and 20 mm above the H.P. Draw its projections, if its end P is in the third quadrant and* Q *in the first quadrant.*



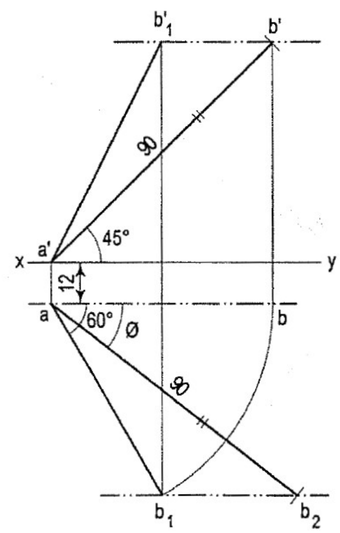
4. The top view of a 75 mm long line AB measures 65 mm, while the length of its front view is 50 mm. Its one end A is in the H.P. and 12 mm in front of the V.P. Draw the projections of AB and determine its inclinations with the H.P. and the V.P.



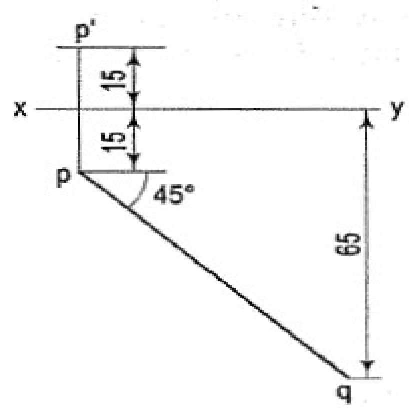
5. A line AB, 65 mm long1 has its end A 20 mm above the H.P. and 25 mm in front of the V.P. The end B is 40 mm above the H.P. and 65 mm in front of the VP. Draw the projections of AB and show its inclinations with the H.P. and the V.P.



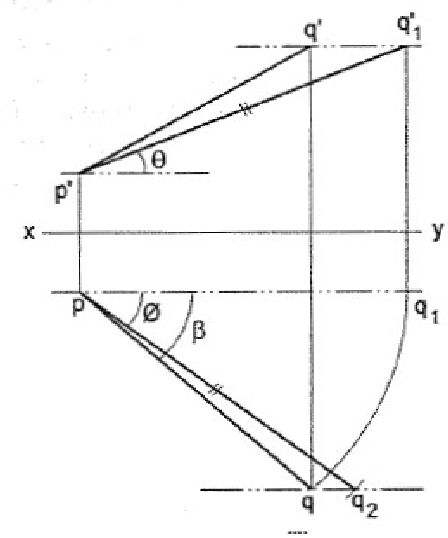
6. A line AB, 90 mm *long, is inclined at 45° to the H.P. and its top view makes an angle of* 60° *with the V.P. The end A is in the H.P. and 12* mm *in front of the V.P. Draw its front view and find its true inclination with the V.P.*



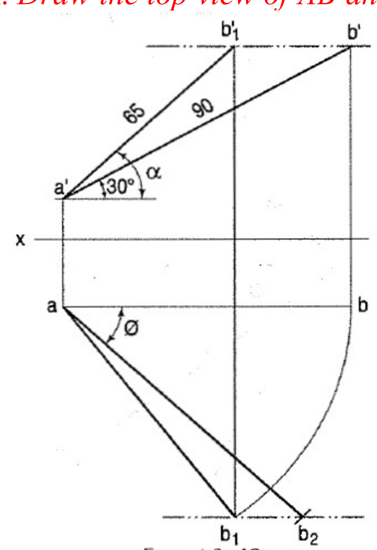
7. Incomplete projections of a line PQ, inclined at 30° to the H.P. are given in figure, Complete the projections and determine the true length of PQ and its inclination with the V.P.



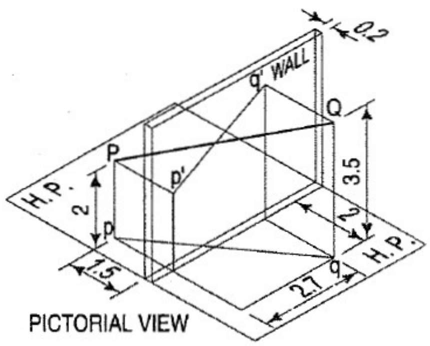
Solution:

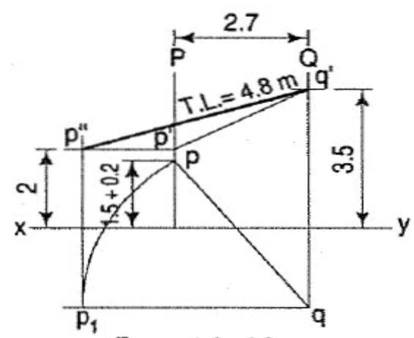


8. A line AB, 90 mm long is inclined at 30° to the H.P. Its end A is 12 mm above the H.P. and 20 mm in front of the V.P. Its front view measures 65 mm. *Draw the top view of AB and determine its inclination with the V.P.*

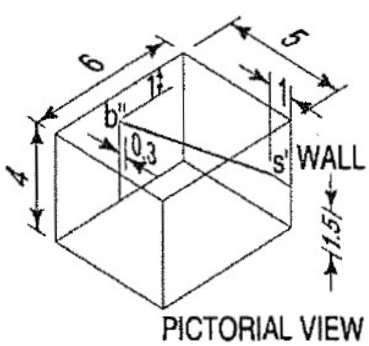


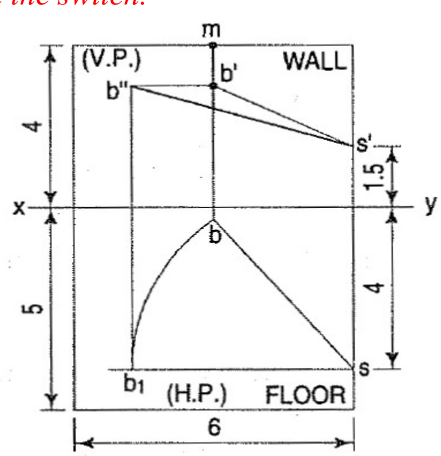
9. Two mangoes on a tree are respectively 2.0 *m and 3.5 m above the ground and 1.5 m and* 2.0 *m away from* 0.2 *m thick compound wall, but on the opposite sides of it. The distance between the mangoes, measured along the ground and parallel to the wall is 2. 7 m. Determine the real distance between the mangoes. Take scale 1 m = 10 mm.*





10. A room 6 *m* x *5 m* x *4 m high has a light-bracket above the centre of the longer wall and 1 m below the ceiling. The light bulb is 0.3 m away from the wall. The switch for the light is on an adjacent wall, 1.5 m above them floor and 1 m from the other longer wall. Determine graphically the shortest distance between the bulb and the switch.*





Exercise Problems

1. A line *AB,* 75 mm long, is inclined at 45° to the H.P. and 30° to the V.P. Its end *B* is in the H.P. and 40 mm in front of the V.P. Draw its projections .

2. Draw the projections of a line *AB,* 90 mm long, its mid-point *M* being 50 mm above the H.P. and 40 mm in front of the V.P. The end *A* is 20 mm above the H.P. and 10 mm in front of the V.P. Determine the inclinations of the line with the H.P. and the V.P.

3. The front view of a 125 mm long line *PQ* measures 75 mm and its top view measures 100 mm. Its end Q and the mid-point *M* are in the first quadrant, *M* being 20 mm from both the planes. Draw the projections of the line *PQ.*

4. A line *PQ,* 100 mm long, is inclined at 45° to the H.P. and at 30° to the V.P. Its end *P* is in the second quadrant and Q is in the fourth quadrant. A point *R* on *PQ,* 40 mm from *P* is in both the planes. Draw the projections of *PQ.*

5. A room is $4.8\,m\ x\ 4.2\,m\ x\ 3.6\,m$ high. Determine graphically the distance between a top corner and the bottom corner diagonally opposite to it.

6. Two oranges on a tree are respectively 1.8 m and 3 m above the ground, and $1.2\,m$ & $2.1\,m$ from a 0.3 m thick wall, but on the opposite sides of it. The distance between the oranges, measured along the ground and parallel to the wall is 2.7 m. Determine the real distance between the oranges.

7. A room is 6 m x 5 m x 3.5 m high. An electric bracket light is above the centre of the longer wall and 1 m below the ceiling. The bulb is 0.3 m away from the wall. The switch for the light is on an adjacent wall, 1.5 m above the floor and 1 m away from the other longer wall. Find graphically the shortest distance between the bulb and the switch.

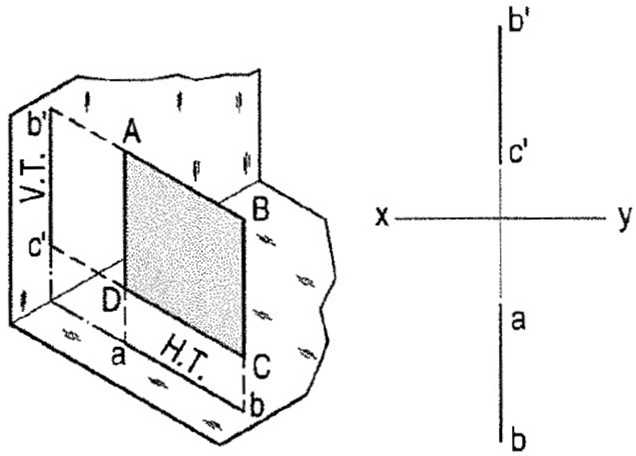
UNIT-III

1. Introduction to regular planes
2. Projection of planes
   - A. Plane Perpendicular to one plane and parallel to another reference plane
   - B. Plane inclined to HP
   - C. Plane inclined to VP
   - D. Plane inclined to both HP and VP.

- Plane figures or surfaces <u>*have only two dimensions*</u>, viz. length and breadth. They do not have thickness. A plane figure may be assumed to be contained by a plane, and its projections can be drawn, if the position of that plane with respect to the principal planes of projection is known.
- Planes which are inclined to both the reference planes are called *oblique planes*.
- A plane, extended if necessary, will meet the reference planes in lines, unless it is parallel to any one of them. These lines are called the *traces* of the plane.
- The line in which the plane meets the H.P. is called the *horizontal trace* or the H.T. of the plane. The line in which it meets the V.P. is called its *vertical trace* or the V.T. A plane is usually represented by its traces.

(i) Perpendicular to both the reference planes.

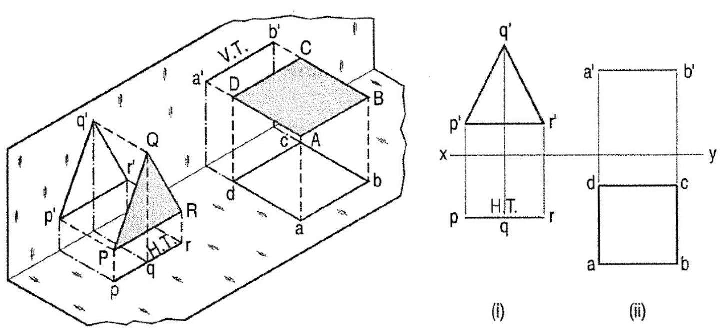
The front view b'c' and the top view ab of the square are both lines



(ii) Perpendicular to one plane and parallel to the other.

(i) A triangle *PQR* is *perpendicular to the H.P. and is parallel to the V.P.* The front view *p'q'r'* shows the exact shape and size of the triangle. The top view *pqr* is a line parallel to *xy.*

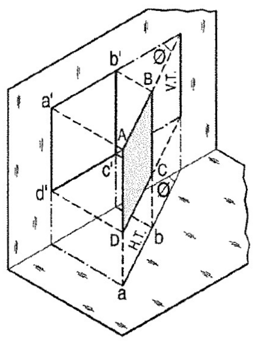
(ii) A square *ABCD* is perpendicular to the V.P. and parallel to the H.P. The top view *abed* shows the true shape and true size of the square. The front view *a'b'* is a line, parallel to *xy.*

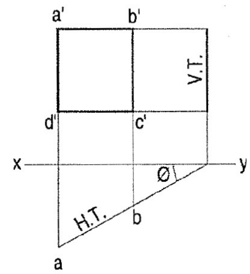


(iii) Perpendicular to one plane and inclined to the other.

(a) Plane, perpendicular to the H.P. and inclined to the V.P.

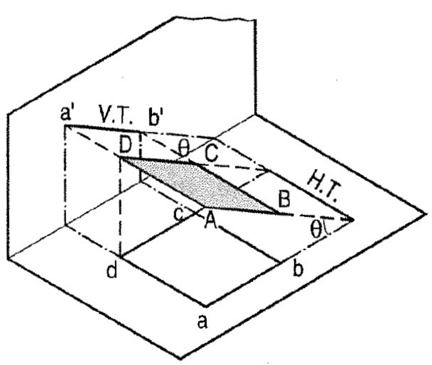
A square *ABCD* is perpendicular to the H.P. and inclined at an angle Ø to the V.P. Its top view *ab* is a line !inclined at Ø to *xy*. The front view *a'b'c'd'* is smaller than *ABCD*.

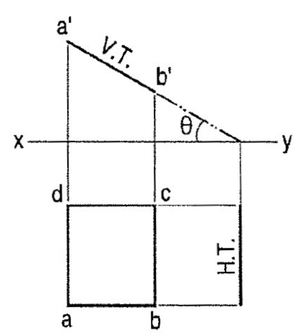




(b) Plane, perpendicular to the V.P. and inclined to the H.P.

A square *ABCD* is perpendicular to the V.P. and inclined at an angle θ to the H.P. Its front view *a'b'* is a line inclined at θ to *xy*. The top view *abcd* is a rectangle which is smaller than the square *ABCD*.





Note:

(a) When a plane is perpendicular to a reference plane, its projection on that plane is a straight line.

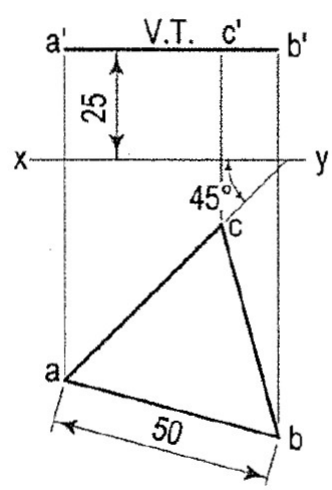
(b) When a plane is parallel to a reference plane, its projection on that plane shows its true shape and size.

(c) When a plane is perpendicular to one of the reference planes and inclined to the other, its inclination is shown by the angle which its projection on the plane to which it is perpendicular, makes with *xy.* Its projection on the plane to which it is inclined, is smaller than the plane itself.

1. An equilateral triangle of 50 mm side has its V.T. parallel to and 25 mm above xy. It has no H. T. Draw its projections when one of its sides is *inclined at 45° to the V.P.*

(i) Draw an equilateral triangle *abc* of 50 mm side, keeping one side, say *ac,* inclined at 45° to *xy.*

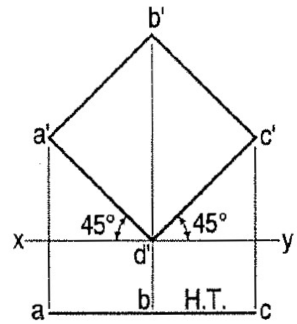
(ii) Project the front view, parallel to and 25 mm *above xy,* as shown.



2. A square ABCD of 40 mm side has a corner on *the H.P. and 20 mm in front of the V.P. All the sides of the square are equally inclined to the H.P. and parallel to the V.P. Draw its projections and show its traces.*

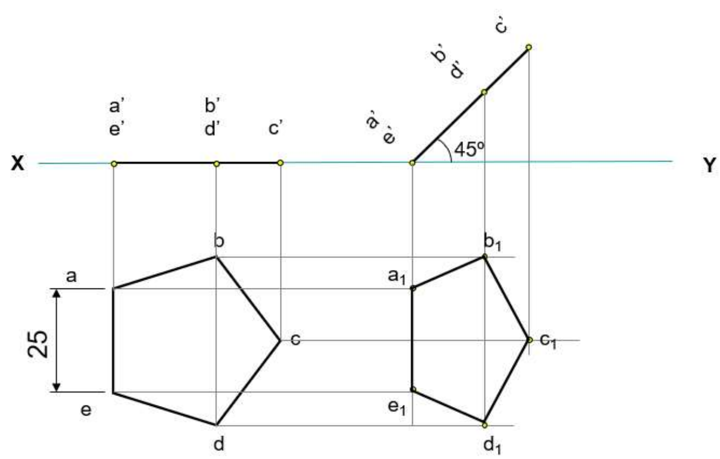
(i) Draw a square *a'b'c'd'* in the front view with one corner in *xy* and all its sides inclined at 45° to *xy*.

(ii) Project the top view keeping the line *ac* parallel to *xy* and 30 mm below it. The top view is its H.T. It has no V.T.

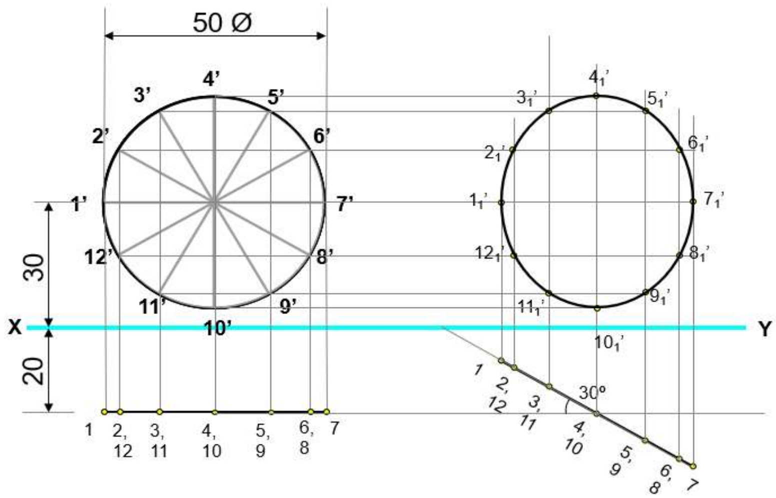


3. A regular pentagon of 25 mm side has one *side* on *the ground. Its plane* is *inclined at 45° to the H.P and perpendicular to the VP. Draw its projections and show its traces.*

Hint: As the plane is inclined to HP, it should be kept parallel to HP with one edge perpendicular to VP



4. Draw the projections of *a circle* of *50* mm *diameter, having its plane vertical and inclined at* 30° *to the V.P. Its centre is 30* mm *above the H.P. and 20* mm *in front* of *the V.P. Show also its traces.*



(iv) Plane inclined to both the reference planes

When a plane has its surface inclined to one plane and an edge or a diameter or a diagonal parallel to that plane and inclined to the other plane, its projections are drawn in three stages.

(1) If the surface of the plane is inclined to the H.P. and an edge (or a diameter or a diagonal) is parallel to the H.P. and inclined to the V.P.,

(i) in the initial position the plane is assumed to be parallel to the H.P. and an edge perpendicular to the V.P.

(ii) It is then tilted so as to make the required angle with the H.P. As already explained, its front view in this position will be a line, while its top view will be smaller in size.

(iii) In the final position, when the plane is turned to the required inclination with the V.P., only the position of the top view will change. Its shape and size will not be affected. In the final front view, the corresponding distances of all the corners from *xy* will remain the same as in the second front view.

Note:

If an edge is in the H.P. or on the ground, in the initial position, the plane is assumed to be lying in the H.P. or on the ground, with the edge perpendicular to the V.P. *If a corner is in the H.P. or on the ground, the line joining that corner with the centre of the plane is kept parallel to the V.P.*

(2) Similarly, if the surface of the plane is inclined to the V.P. and an edge (or a diameter or a diagonal) is parallel to the V.P. and inclined to the H.P.,

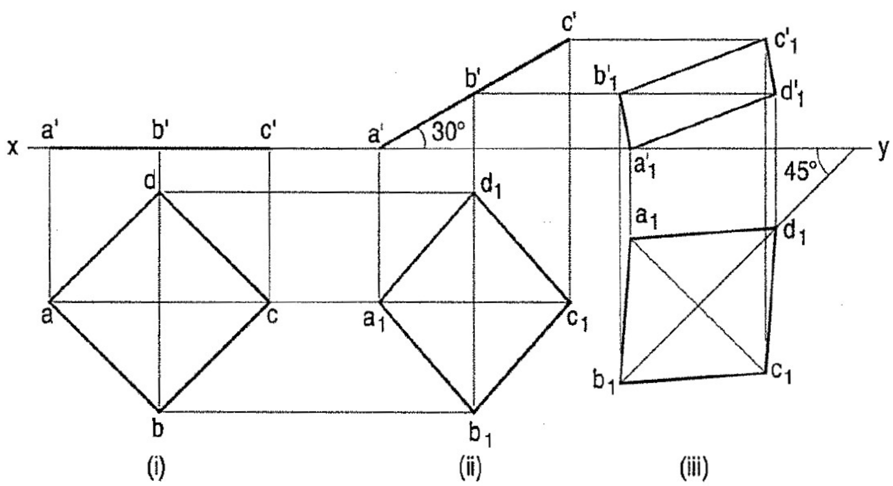
(i) In the initial position, the plane is assumed to be parallel to the V.P. and an edge perpendicular to the H.P.

(ii) It is then tilted so as to make the required angle with the V.P. Its top view in this position will be a line, while its front view will be smaller in size.

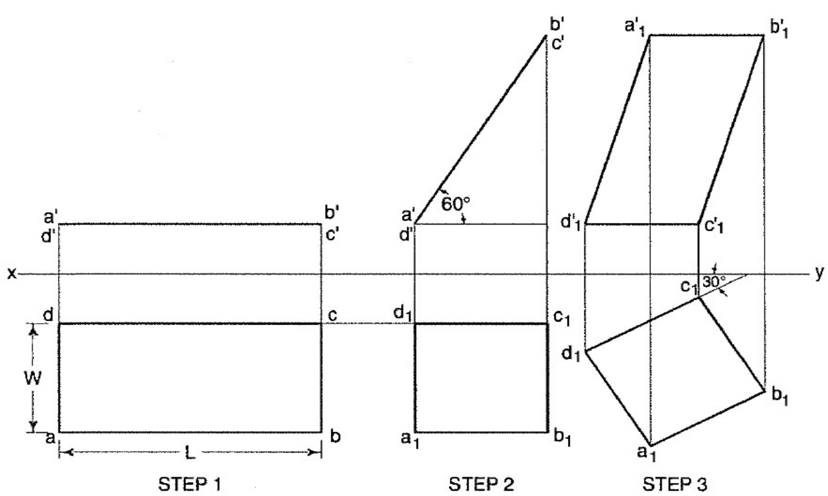
(iii) When the plane is turned to the required inclination with the H.P., only the position of the front view will change. Its shape and size will not be affected. In the final top view, the corresponding distances of all the corners from *xy* will remain the same as in the second top view.

If an edge is in the V.P., in the initial position, the plane is assumed to be lying in the V.P. with an edge perpendicular to the H.P. If a corner is in the V.P., the line joining that corner with centre of the plane is kept parallel to the H.P.

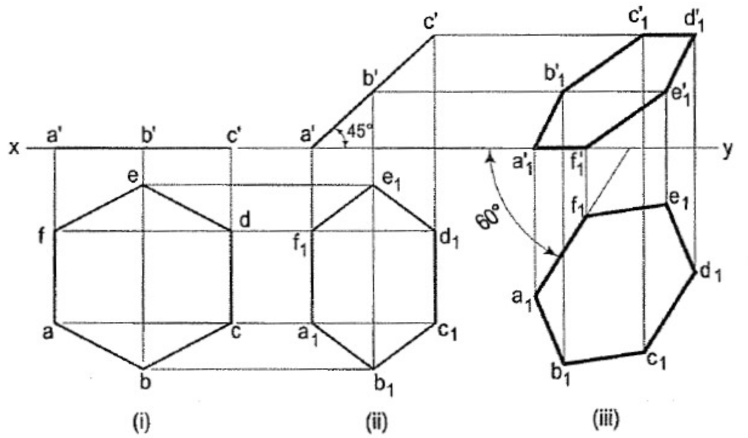
1. A *square ABCD of* 50 *mm side has its corner, A in the H.P., its diagonal AC inclined at* 30° *to the H.P. and the diagonal BD inclined at 45° to the V.P. and parallel to the H.P. Draw its projections*



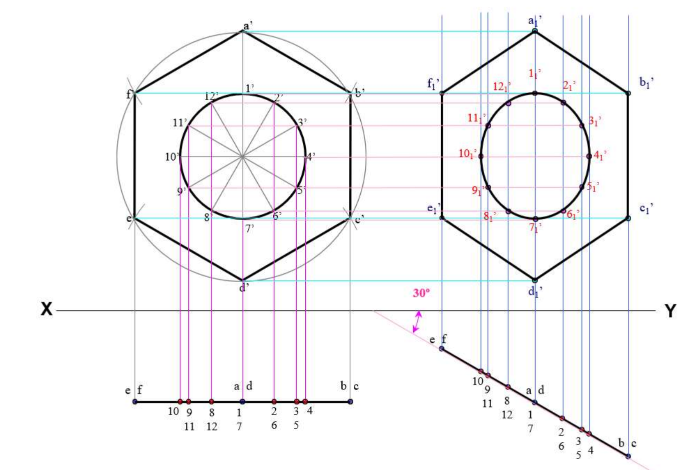
2. *A rectangular plane surface of size L × W is positioned in the first quadrant and is inclined at an angle of* 60° *with the H.P. and 30° with the V.P. Draw its projections.*



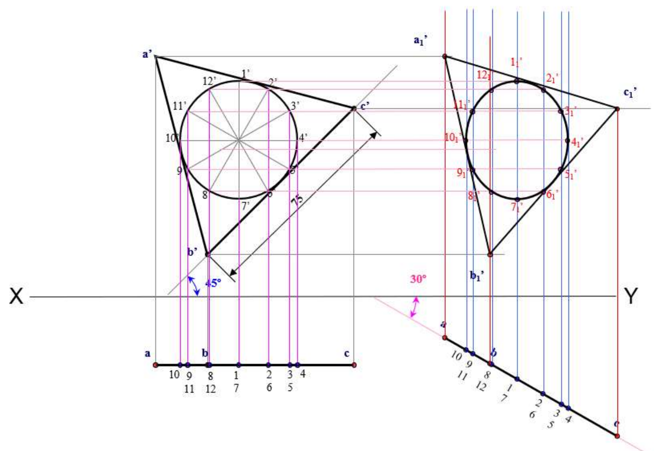
3. Draw the projections of a regular hexagon of 25 mm side, having one of its sides in *the H.P. and inclined at* 60° *to the V.P., and its surface making an angle of 45° with the H.P.*



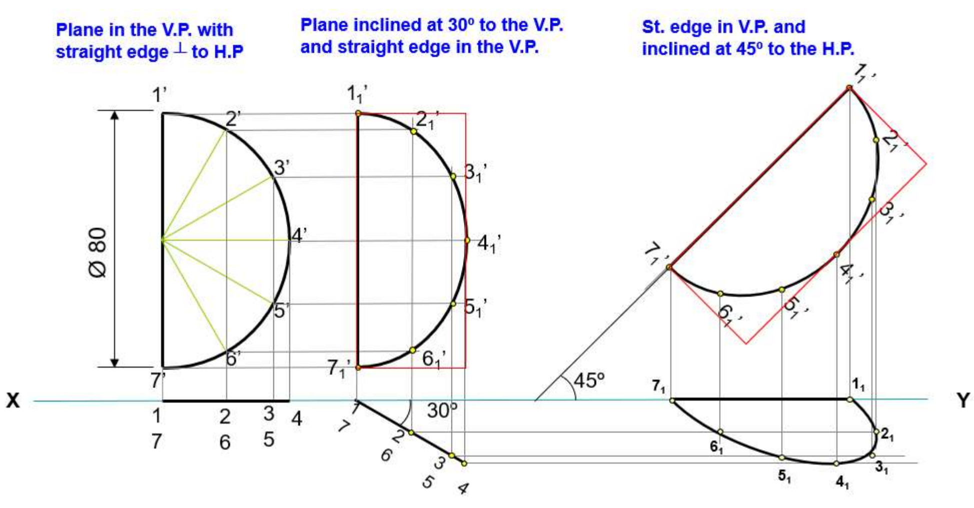
4. Draw a regular hexagon of 40 mm sides, with its two sides vertical. Draw a circle of 40 mm diameter in its centre. The figure represents a hexagonal plate with a hole in it and having its surface parallel to the VP. Draw its projections when the surface is vertical and inclined at 30° to the VP.



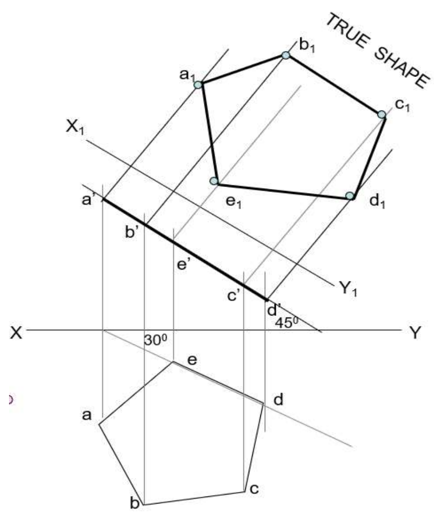
5. Draw an equilateral triangle of 75 mm sides and inscribe a circle in it. Draw the projections of the figure, when its plane is vertical and inclined at 30º to the VP and one of the sides of the triangle is inclined at 45º to the HP.



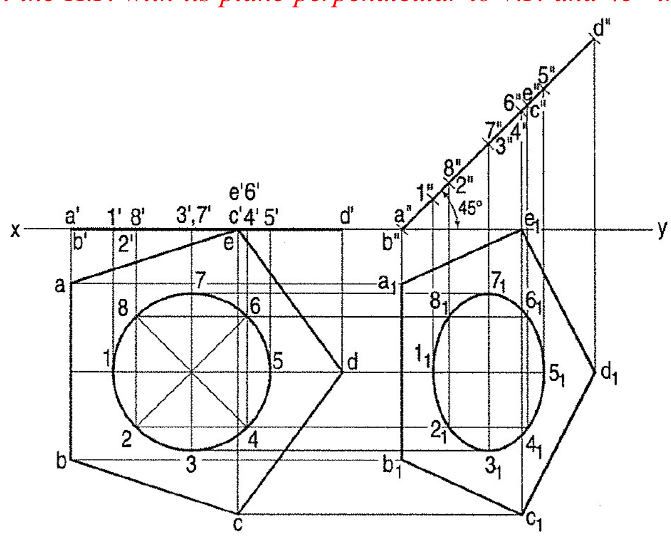
6. A semicircular plate of 80mm diameter has its straight edge in the VP and inclined at 45 to HP. The surface of the plate makes an angle of 30 with the VP. Draw its projections.



7. *Draw a regular pentagon of 30 mm sides with one side 30^0 inclined to xy. This figure is TV of some plane whose FV is a line 45^0 inclined to xy. Determine it's true shape.*



8. *A pentagonal plate of 45 mm side has a circular hole of 40 mm diameter in its centre. The plane stands on one of its sides on the H.P. with its plane perpendicular to V.P. and 45° inclined to the H.P. Draw the projections.*



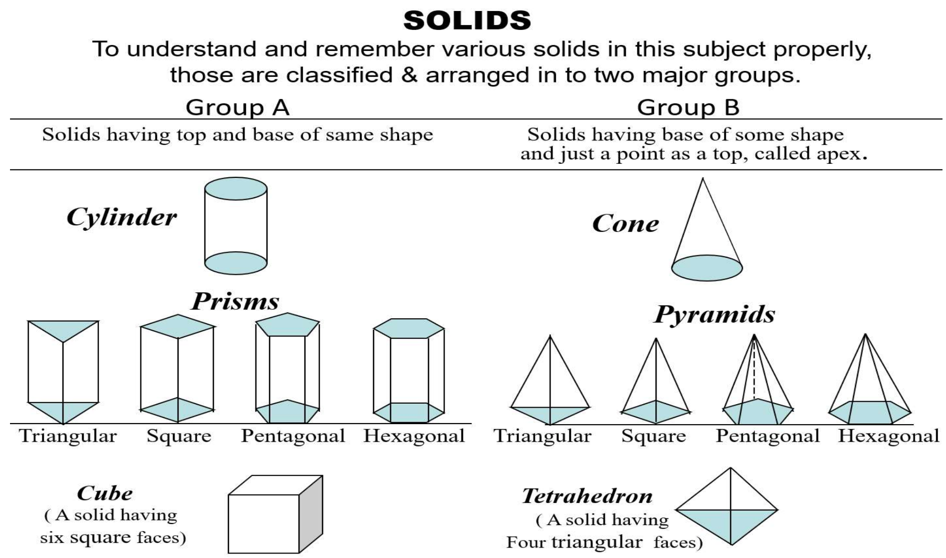
Exercise problems

1. Draw an equilateral triangle of 75 mm side and inscribe a circle in it. Draw the projections of the figure, when its plane is vertical and inclined at 30° to the V.P. and one of the sides of the triangle is inclined at 45° to the H.P.
2. A regular hexagon of 40 mm side has a corner in the H.P. Its surface is inclined at 45° to the H.P. and the top view of the diagonal through the corner which is in the H.P. makes an angle of 60° with the V.P. Draw its projections.
3. Draw the projections of a regular pentagon of 40 mm side, having its surface inclined at 30° to the H.P. and a side parallel to the H.P. and inclined at an angle of 60° to the V.P.
4. Draw the projections of a circle of 75 mm diameter having the end *A* of the diameter *AB* in the H.P., the end *B* in the V.P., and the surface inclined at 30° to the H.P. and at 60° to the V.P.

UNIT-IV

1. Introduction to solids and its types
2. Projection of solids
   A. With the axis perpendicular to one plane and parallel to the reference plane.
   B. With the axis inclined to one reference plane.
   C. With the axes inclined to both the reference planes.

Solids may be divided into two main groups: Polyhedra and Solids of revolution



(1) Polyhedra: A polyhedron is defined as a solid bounded by planes called *faces.* When all the faces are equal and regular, the polyhedron is said to be regular.

There are *seven* regular polyhedra which may be defined as stated below:

(i) ***Tetrahedron*****:** It has four equal faces, each an equilateral triangle.

(ii) ***Cube or hexahedron*****:** It has six faces, all equal squares.

(iii) Octahedron**:** It has eight equal equilateral triangles as faces.

(iv) Dodecahedron**:** It has twelve equal and regular pentagons as faces.

(v) ***Icosahedron*****:** It has twenty faces, all equal equilateral triangles.

(vi) Prism: This is a polyhedron having two equal and similar faces called its ends or bases, parallel to each other and joined by other faces which are parallelograms. The imaginary line joining the centres of the bases is called the axis. right and regular prism has its axis perpendicular to the bases. All its faces are equal rectangles.

(vii) Pyramid: This is a polyhedron having a plane figure as a base and a number of triangular faces meeting at a point called the vertex or apex. The imaginary line joining the apex with the centre of the base is its axis. A right and regular pyramid has its axis perpendicular to the base which is a regular plane figure. Its faces are all equal isosceles triangles.

Oblique prisms and pyramids have their axes inclined to their bases. Prisms and pyramids are named according to the shape of their bases, as triangular, square, pentagonal, hexagonal etc.

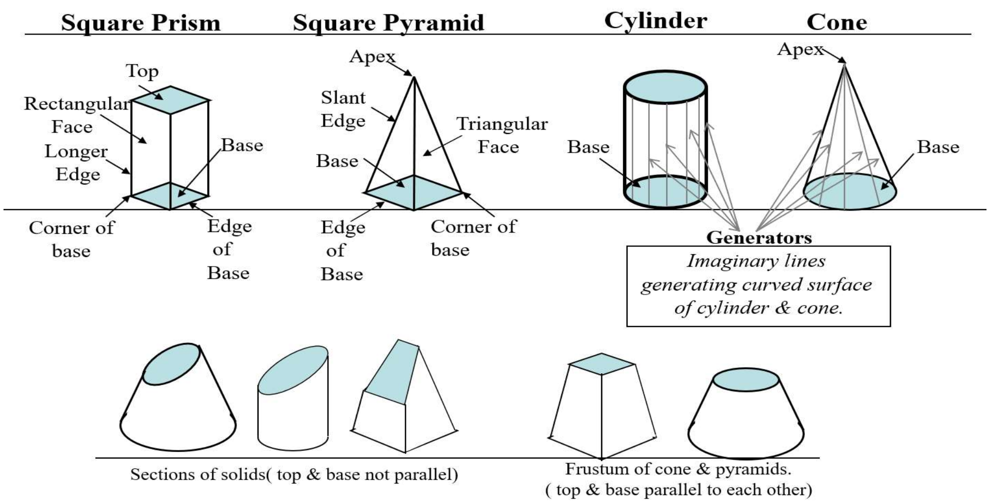
(2) Solids of revolution:

(i) *Cylinder* : A *right circular cylinder* is a solid generated by the revolution of a rectangle about one of its sides which remains fixed. It has two equal circular bases. The line joining the centres of the bases is the axis. It is perpendicular to the bases.

(ii) *Cone:* A *right circular cone* is a solid generated by the revolution of a right-angled triangle about one of its perpendicular sides which is fixed.

It has one circular base. Its axis joins the apex with the centre of the base to which it is perpendicular. Straight lines drawn from the apex to the circumference of the base-circle are all equal and are called *generators* of the cone. The length of the generator is the slant height of the cone.

SOLIDS
Dimensional parameters of different solids.



(iii) *Sphere*: A *sphere* is a solid generated by the revolution of a semi-circle about its diameter as the axis. The mid-point of the diameter is the centre of the sphere. All points on the surface of the sphere are equidistant from its centre.

Oblique cylinders and cones have their axes inclined to their bases.

(iv) *Frustum:* When a pyramid or a cone is cut by a plane parallel to its base, thus removing the top portion, the remaining portion is called its *frustum*

(v) *Truncated:* When a solid is cut by a plane inclined to the base it is said to be *truncated.*

STEPS TO SOLVE PROBLEMS IN SOLIDS

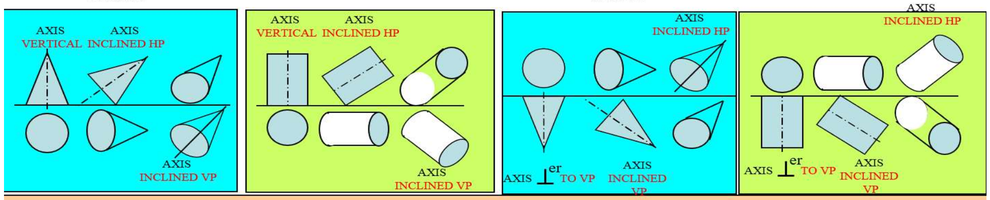
(IF IT IS INCLINED TO HP, ASSUME IT STANDING ON HP)
(IF IT IS INCLINED TO VP, ASSUME IT STANDING ON VP)
IF STANDING ON HP - IT'S TV WILL BE TRUE SHAPE OF IT'S BASE OR TOP:
IF STANDING ON VP - IT'S FV WILL BE TRUE SHAPE OF IT'S BASE OR TOP.
IT'S OTHER VIEW WILL BE A RECTANGLE (IF SOLID IS CYLINDER OR 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.

GENERAL PATTERN (THREE STEPS) OF SOLUTION:

GROUP B SOLID. CONE	**GROUP A SOLID. CYLINDER**	**GROUP B SOLID. CONE**	**GROUP A SOLID. CYLINDER**

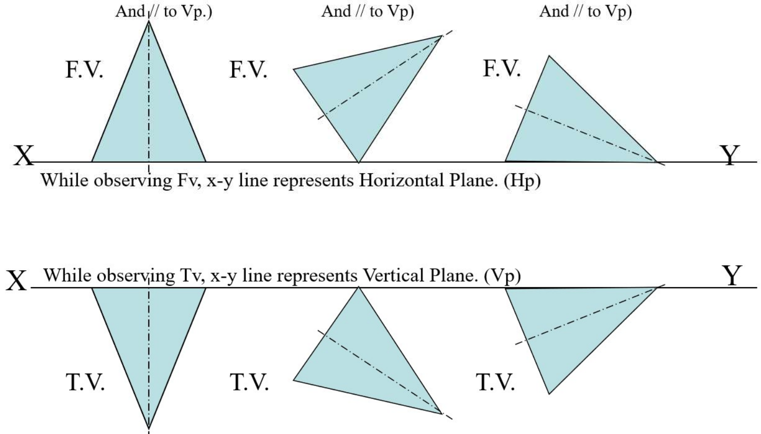


Three steps If solid is inclined to Hp	**Three steps If solid is inclined to Hp**	**Three steps If solid is inclined to Vp**	**Three steps If solid is inclined to Vp**

STANDING ON H.P
On it's base.
(Axis perpendicular to Hp
And // to Vp.)

RESTING ON H.P
On one point of base circle.
(Axis inclined to Hp
And // to Vp)

LYING ON H.P
On one generator.
(Axis inclined to Hp
And // to Vp)



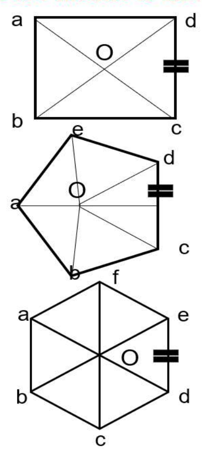
STANDING ON V.P
On it's base.
Axis perpendicular to Vp
And // to Hp

RESTING ON V.P
On one point of base circle.
Axis inclined to Vp
And // to Hp

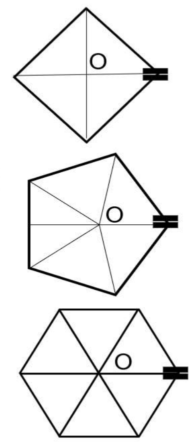
LYING ON V.P
On one generator.
Axis inclined to Vp
And // to Hp

- Edge in HP/VP
- Face in HP/VP
- Edge incline to HP/VP
- Face incline to HP/VP

- Corner in HP/VP
- Slant edge in HP/VP
- Slant edge incline to HP/VP

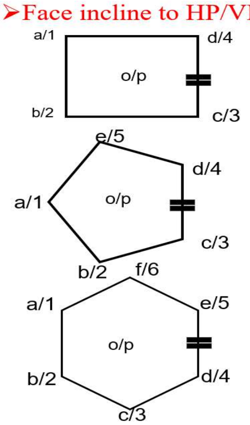


TS of Pyramid

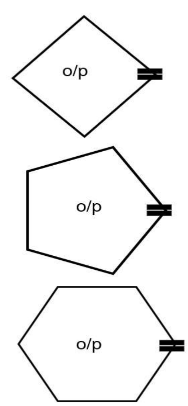


- Edge in HP/VP
- Face in HP/VP
- Edge incline to HP/VP
- Face incline to HP/VP

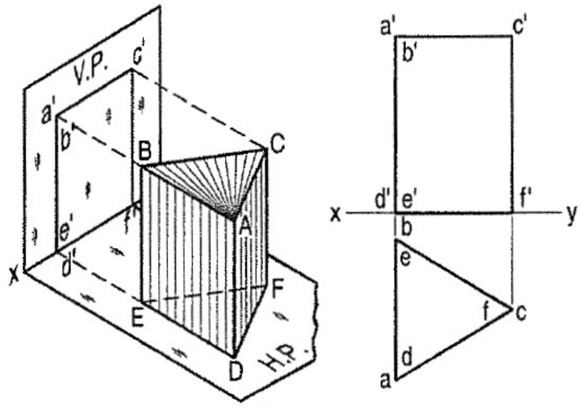
- Corner in HP/VP
- Slant edge in HP/VP
- Slant edge incline to HP/VP



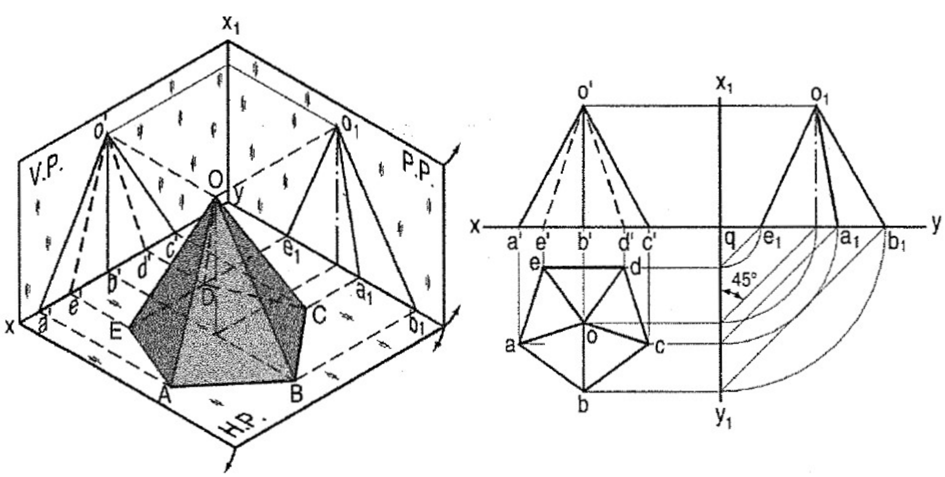
TS of Prism



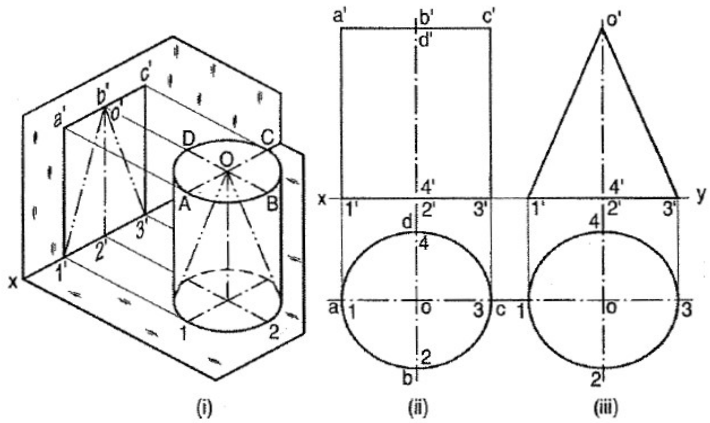
1. Draw the projections of a triangular prism, base 40 mm *side and axis 50* mm *long, resting on one of its bases on the H.P. with a vertical face perpendicular to the V.P.*



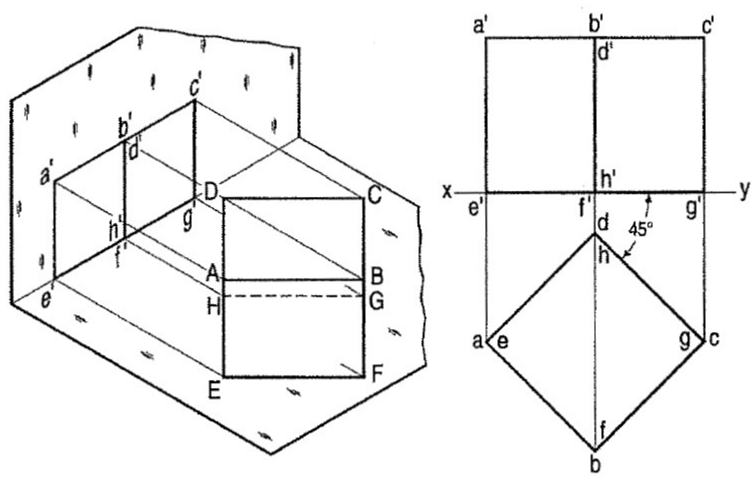
2. Draw the projections of a pentagonal pyramid, base 30 mm edge and axis 50 mm long, having its base on the H.P. and an edge of the base parallel to the V.P. Also draw its side view.



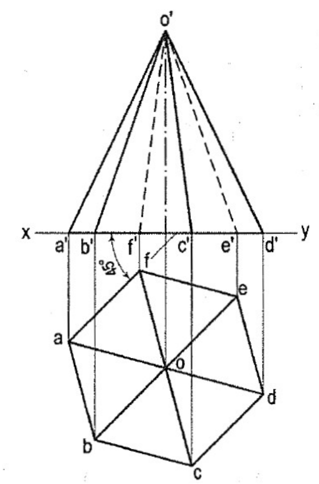
3. Draw the projections of (i) a cylinder, base 40 mm diameter and axis 50 mm Jong, and (ii) a cone, base 40 mm diameter and axis 50 mm long, resting on *the H.P. on their respective bases.*



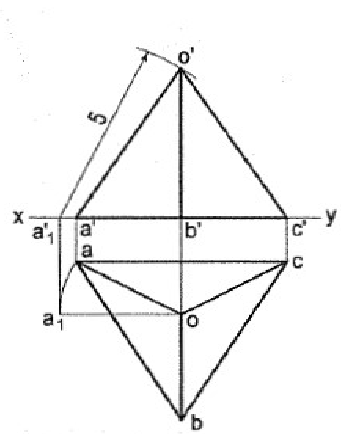
4. A cube of 50 mm long edges is resting on the H.P. with its vertical faces equally inclined to the V.P. Draw its projections.



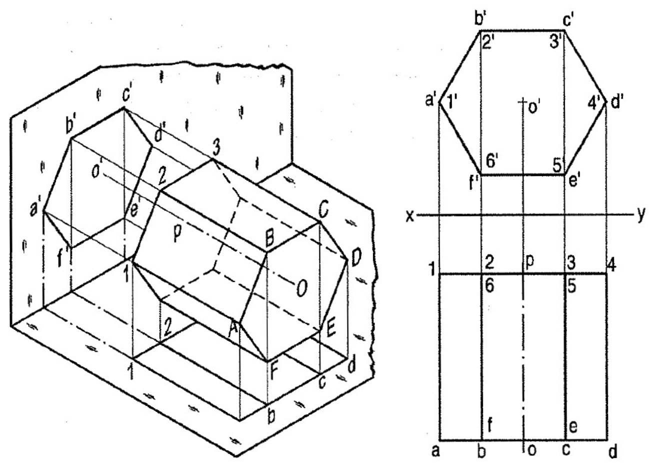
5. Draw the projections of a hexagonal pyramid, base 30 mm side and axis 60 mm long, having its base on the H.P. and one of the edges of the base inclined at 45° to the V.P.



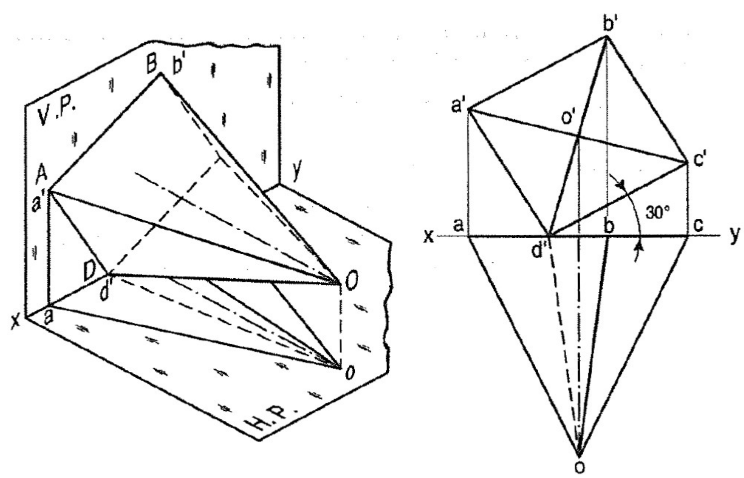
6. A tetrahedron of 5 cm long edges is resting on the H.P. on one of its faces, with an edge of that face parallel to the V.P. Draw its projections and measure the distance of its apex from the ground.



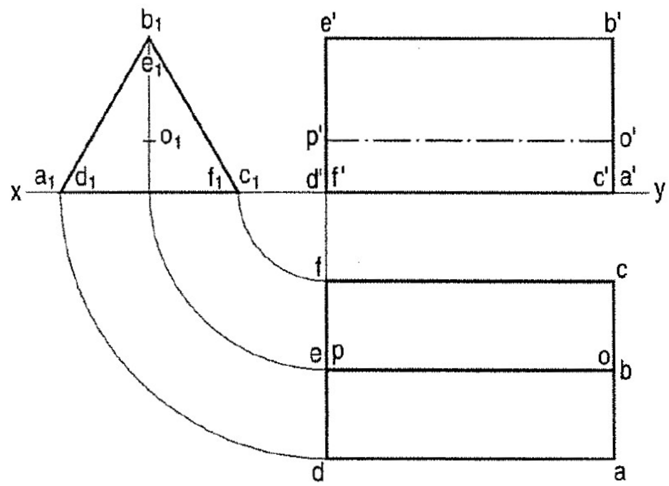
7. A hexagonal prism has one of its rectangular faces parallel to the H.P. Its axis is perpendicular to the V.P. and 3.5 cm *above the ground. Draw its projections when the nearer end is 2* cm *in front of the V.P. Side of base 2.5* cm *long; axis 5* cm *long.*



8. A square pyramid, base 40 mm side and axis 65 mm long, has its base in the V.P. One edge of the base is inclined at 30° to the H.P. and a corner contained by that edge is on the H.P. Draw its projections.



9. A triangular prism, base 40 mm side and height 65 mm is resting on the H.P. on one of its rectangular faces with the axis parallel to the V.P. Draw its projections.



Draw the projections of the following solids, situated in their respective positions, taking a side of the base 40 mm long or the diameter of the base 50 mm long and the axis 65 mm long.

1. A hexagonal pyramid, base on the H.P. and a side of the base parallel to and 25 mm in front of the V.P.
2. A square prism, base on the H.P., a side of the base inclined at 30° to the V.P. and the axis 50 mm in front of the V.P.
3. A triangular pyramid, base on the H.P. and an edge of the base inclined at 45° to the V.P.; the apex 40 mm in front of the V.P.
4. A cylinder, axis perpendicular to the V.P. and 40 mm above the H.P., one end 20 mm in front of the V.P.

5. A pentagonal prism, a rectangular face parallel to and 10 mm above the H.P., axis perpendicular to the V.P. and one base in the V.P.

6. A square pyramid, all edges of the base equally inclined to the H.P. and the axis parallel to and 50 mm away from both the H.P. and the V.P.

7. A cone, apex in the H.P. axis vertical and 40 mm in front of the V.P.

8. A pentagonal pyramid, base in the V.P. and an edge of the base in the H.P.

When a solid has its axis inclined to one plane and parallel to the other, its projections are drawn in two stages.

(1) In the initial stage, the solid is assumed to be in simple position, i.e. *its axis perpendicular to one of the planes.*

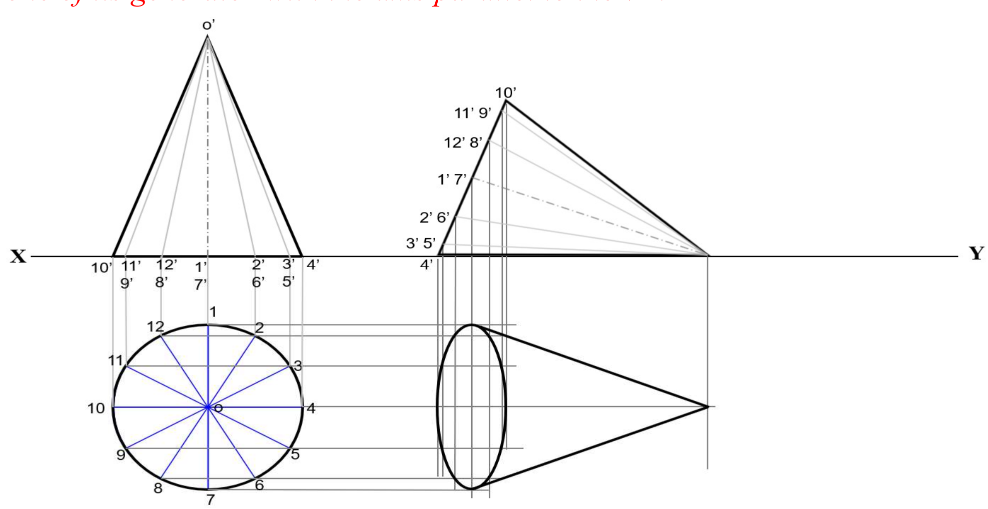
If the axis is to be inclined to the ground, i.e. the H.P., it is assumed to be perpendicular to the H.P. in the initial stage. Similarly, if the axis is to be inclined to the V.P., it is kept perpendicular to the V.P. in the initial stage.

Moreover

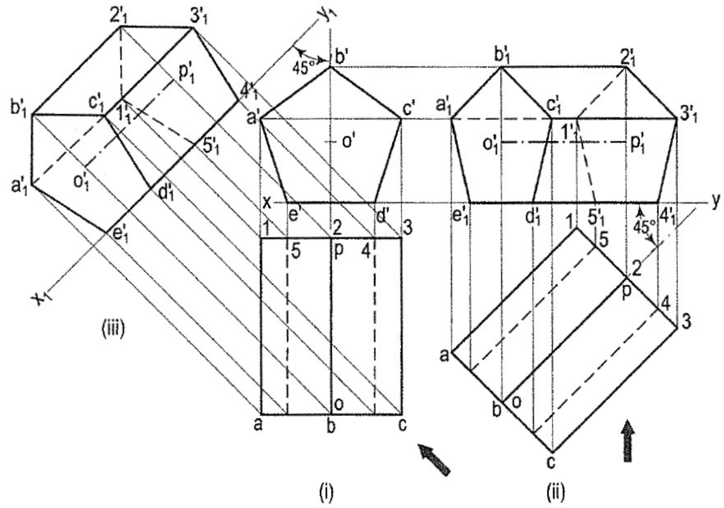
(i) if the solid has an edge of its base parallel to the H.P. or in the H.P. or on the ground, that edge should be kept perpendicular to the V.P.; if the edge of the base is parallel to the V.P. or in the V.P., it should be kept perpendicular to the H.P.

(ii) If the solid has a corner of its base in the H.P. or on the ground, the sides of the base containing that corner should be kept equally inclined to the V.P.; if the corner is in the V.P., they should be kept equally inclined to the H.P.

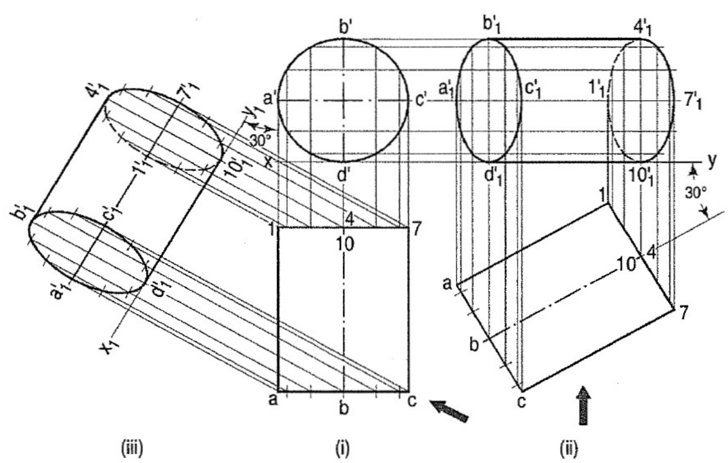
10. Draw the projections of a cone, base 75 mm diameter and axis 100 mm long, lying on the HP on one of its generator with the axis parallel to the VP.



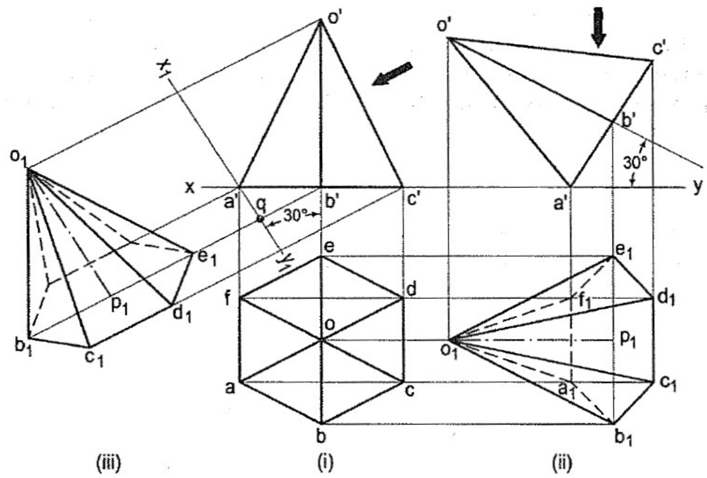
11. Draw the projections of a pentagonal prism, base 25 mm side and axis 50 mm long, on one of its rectangular faces on the HP., with the axis inclined at 45° to the V.P.



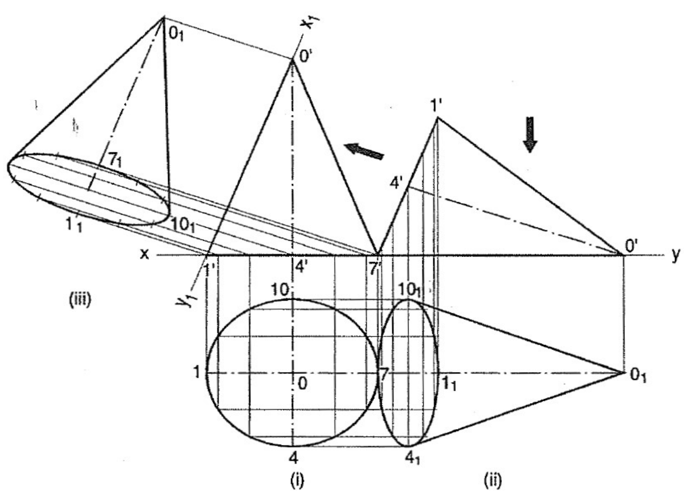
12. Draw the projections of a cylinder 75 mm diameter and 100 mm long, lying on the ground with its axis inclined at 30° to the V.P. and parallel to the ground.



13. A hexagonal pyramid, base 25 mm side and axis 50 mm long, has an edge of its base on *the ground. Its axis is inclined at 30° to the ground and parallel to the V.P. Draw its projections.*



14. Draw the projections of a cone, base 75 mm diameter and axis 100 mm long, lying on the H.P. on one of its generators with the axis parallel to the V.P.



The projections of a solid with its axis inclined to both the planes are drawn in three stages:

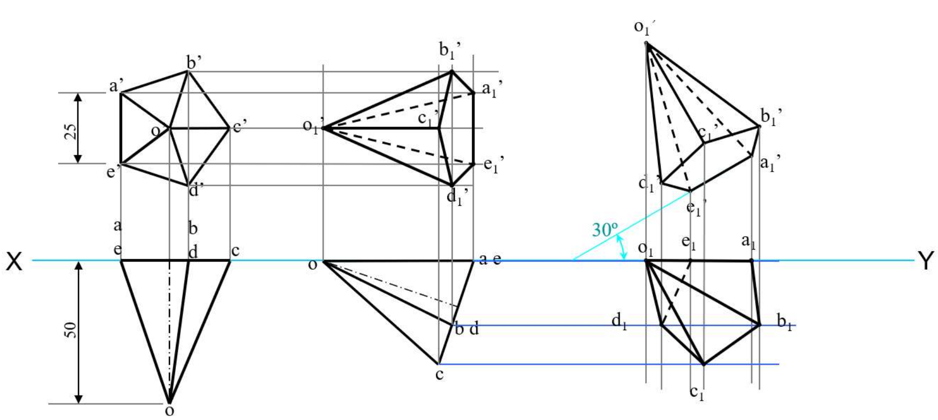
(i) Simple position

(ii) Axis inclined to one plane and parallel to the other

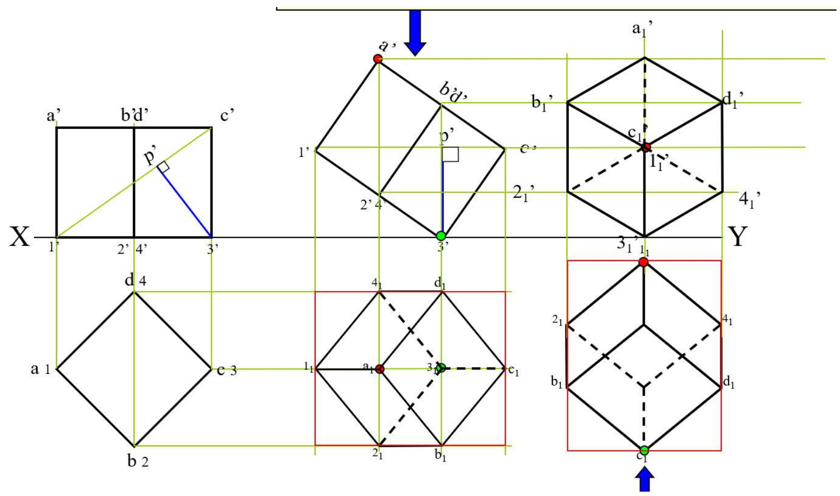
(iii) Final position.

The second and final positions may be obtained either by the alteration of the positions of the solid, i.e. the views, or by the alteration of reference lines.

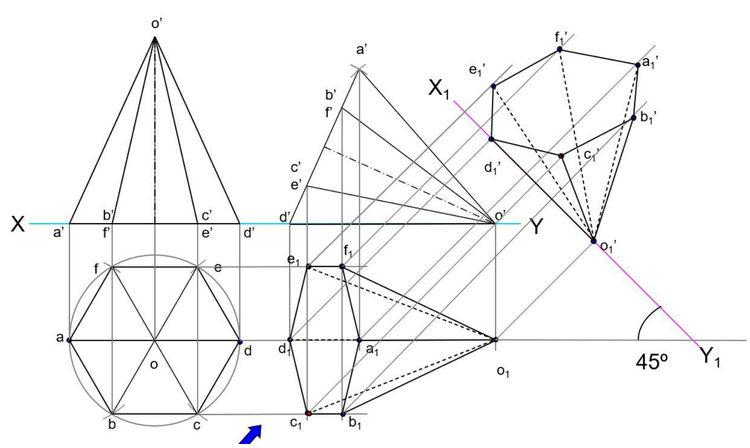
15. A pentagonal pyramid base 25 mm side and axis 50 mm long has one of its triangular faces in the VP and the edge of the base contained by that face makes an angle of 30º with the HP. Draw its projections.



16. A cube of 25 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.



17. A hexagonal pyramid base 25 mm side and axis 55 mm long has one of its slant edge on the ground. A plane containing that edge and the axis is perpendicular to the H.P. and inclined at 45º to the V.P. Draw its projections when the apex is nearer to the V.P. than the base.



UNIT-V

1. Introduction to section of solids
2. Section of solids and sectional view, true shape. Solids in simple position and cutting plane inclined to one reference plane only.
   A. Section of prism.
   B. Section of pyramid.
   C. Section of cone.
   D. Section of cylinder.
3. Development of surface of solids: Development of truncated prism, pyramid, cone and cylinder- frustum of cone and pyramid.

- It is customary to imagine the object as being cut through or *sectioned* by planes. The part of the object between the cutting plane and the observer is assumed to be removed and the view is then shown *in section*.
- The imaginary plane is called a section *plane* or a *cutting plane*. The surface produced by cutting the object by the section plane is called the *section*. It is indicated by thin section lines uniformly spaced and inclined at 45°.
- The projection of the section along with the remaining portion of the object is called a *sectional view.*
- Section planes are generally perpendicular planes. They may be perpendicular to one of the reference planes and either perpendicular, parallel or inclined to the other plane.

- Sections: The projection of the section on the reference plane to which the section plane is perpendicular, will be a straight line coinciding with the trace of the section plane on it. Its projection on the other plane to which it is inclined is called *apparent section*. This is obtained by

(i) projecting on the other plane, the points at which the trace of the section plane intersects the edges of the solid and

(ii) drawing lines joining these points in proper sequence.

- True shape of a section: The projection of the section on a plane parallel to the section plane will show the true shape of the section. Thus, when the section plane is parallel to the H.P. or the ground, the true shape of the section will be seen in *sectional top view.* When it is parallel to the V.P., the true shape will be visible in the *sectional front view.*

- Imagine that a solid is enclosed in a wrapper of thin material, such as paper. If this covering is opened out and laid on a flat plane, the flattened-out paper is the development of the solid. Thus, when surfaces of a solid are laid out on a plane, the figure obtained is called its development.
- *Methods of development.*

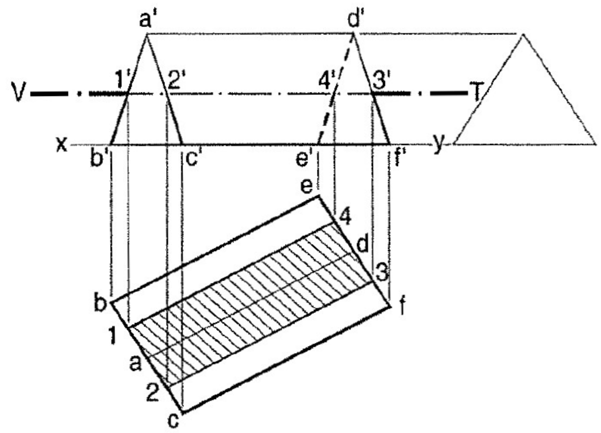
1. *Parallel-line development:* It is employed in case of prisms and cylinders in which stretch-out-line principle is used.

2. *Radial-line development:* It is used for pyramids and cones in which the true length of the slant edge or the generator is used as radius.

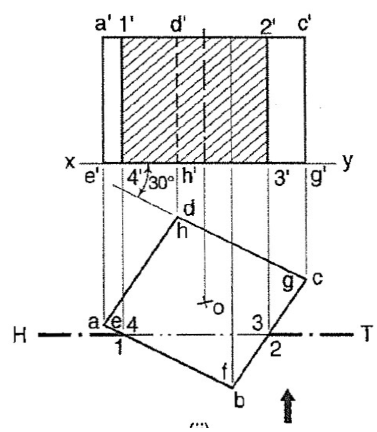
3. *Triangulation development:* This is used to develop transition pieces. This is simply a method of dividing a surface into a number of triangles and transferring them into the development.

4. *Approximate method:* It is used to develop objects of double curved or warped surfaces as sphere, paraboloid, ellipsoid, hyperboloid and helicoid.

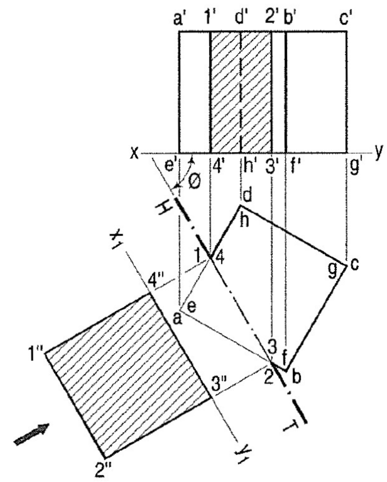
1. A triangular prism, base 30 mm side and axis 50 mm long, is lying on the H.P. on one of its rectangular faces with its axis inclined at 30° to the V.P. It is cut by a horizontal section plane, at a distance of 12 mm above the ground. Draw its front view and sectional top view.



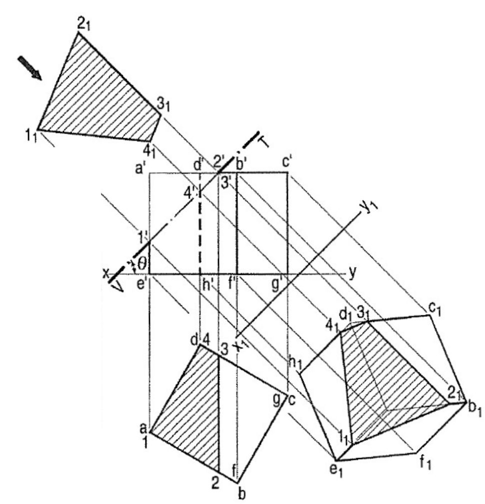
2. A cube of 35 mm long edges is resting on the H.P. on one of its faces with a vertical face inclined at 30° to the V.P. It is cut by a section plane parallel to the V.P. and 9 mm away from the axis and further away from the V.P. Draw its sectional front view and the top view.



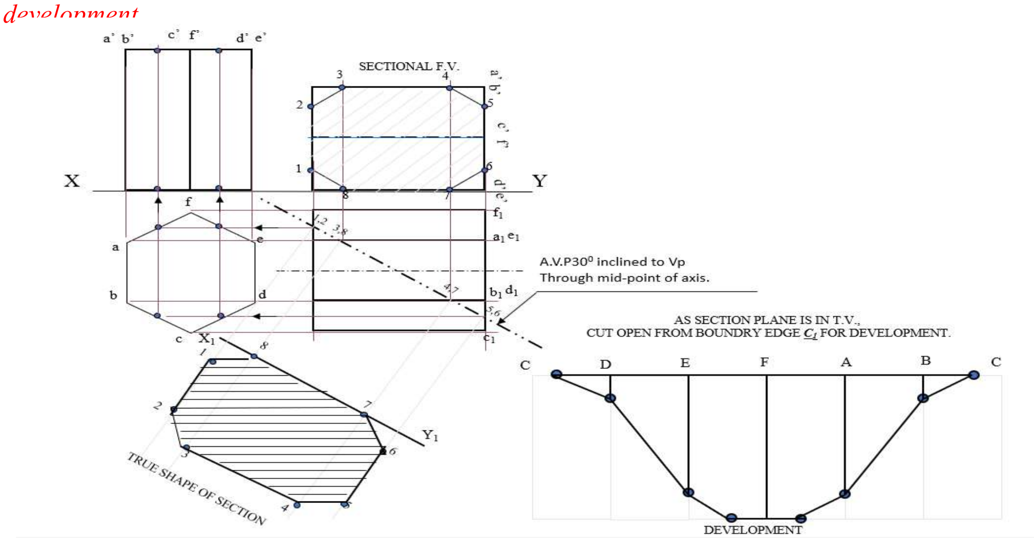
3. A cube of 35 mm long edges is resting on the H.P. on one of its faces with a vertical face inclined at 30° to the V.P. It is cut by a section plane, inclined at 60° to the V.P. and perpendicular to the H.P., so that the face which makes 60° angle with the V.P. is cut in two equal halves. Draw the sectional front view, top view and true shape of the section.



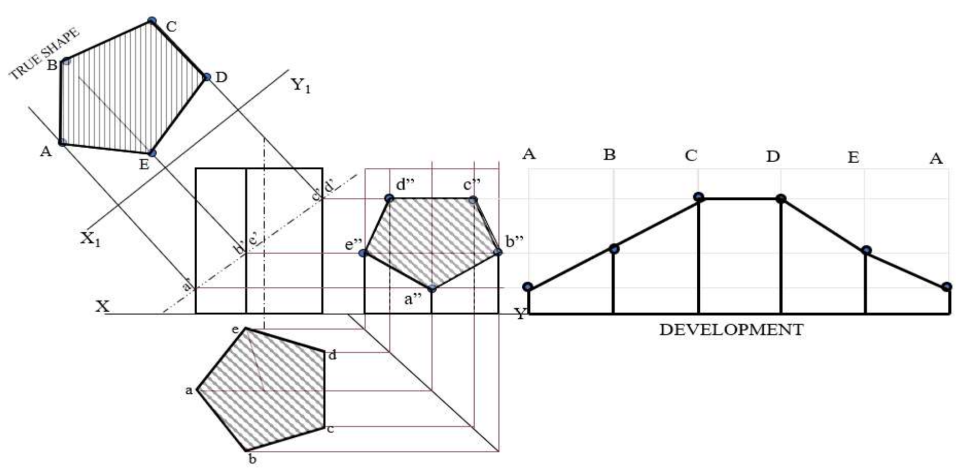
4. A cube of 35 mm long edges is resting on the H.P. on one of its faces with a vertical face inclined at 30° to the V.P. It is cut by a section plane, perpendicular to the V.P., inclined at 45° to the H.P. and passing through the top end of the axis. (i) Draw its front view, sectional top view and true shape of the section. (ii) Project another top view on an auxiliary plane, parallel to the section plane.



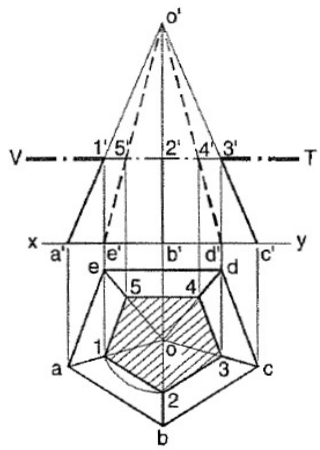
5. A hexagonal prism. 30 mm base side & 55 mm axis is lying on Hp on it's rectangular face with axis parallel to VP. It is cut by a section plane normal to Hp and 30^0 inclined to VP bisecting axis. Draw sec. Views, true shape & development



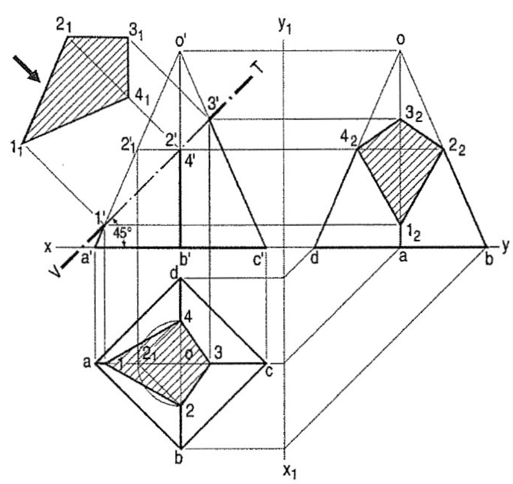
6. A pentagonal prism , 30 mm base side & 50 mm axis is standing on Hp on it's base with one side of the base perpendicular to VP. It is cut by a section plane inclined at 40° to the HP, through mid point of axis. Draw FV, sec. TV & sec. Side view. Also draw true shape of section and Development of surface of remaining solid.



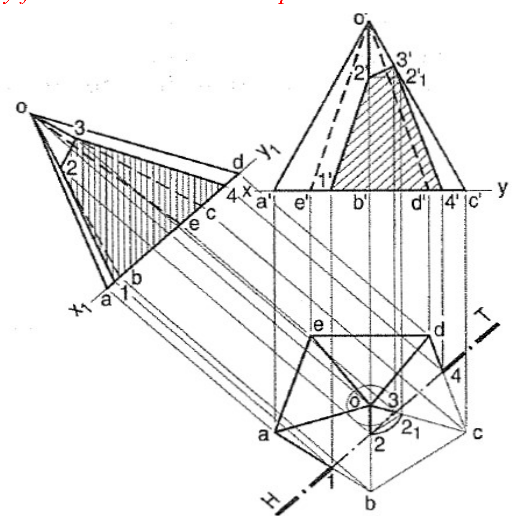
7. A pentagonal pyramid, base 30 mm side and axis 65 mm long has its base horizontal and an edge of the base parallel to the V.P. A horizontal section plane cuts it at a distance of 25 mm above the base. Draw its· from view *and sectional top view.*



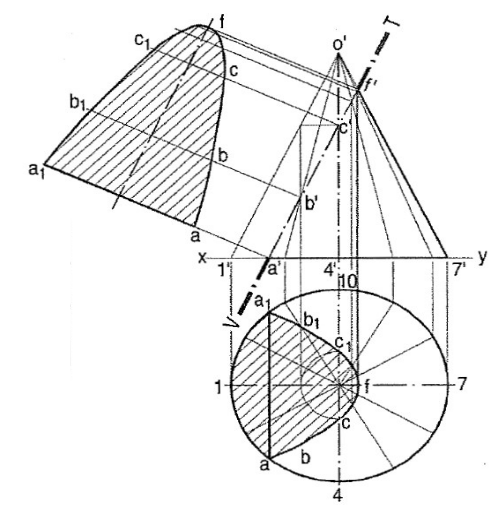
8. A square pyramid, base 40 mm *side and axis 65* mm *long, has its base on the H.P. and all the edges of the base equally inclined to the V.P. It is cut by a section plane, perpendicular to the V.P., inclined at 45° to the H.P. and bisecting the axis. Draw its sectional top view, sectional side view and true shape of the section.*



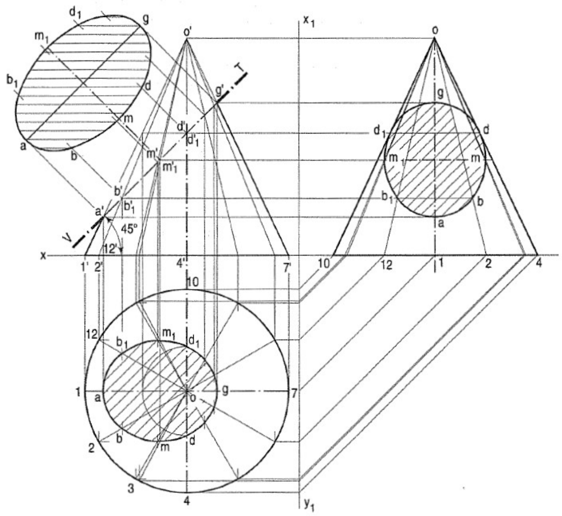
9. A pentagonal pyramid has its base on the H.P. and the edge of the base nearer the V.P., parallel to it. A vertical section plane, inclined at 45° to the V.P., cuts the pyramid at a distance of 6 mm from the axis. Draw the top view, sectional front view and the auxiliary front view on an A. V.P. parallel to the section plane. Base of the pyramid 30 mm side; axis 50 mm long.



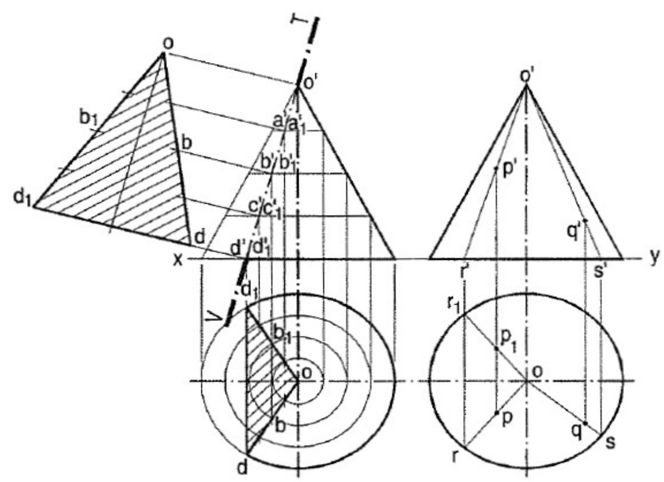
10. A cone, base 75 mm diameter and axis 80 mm long is resting on its base on the H.P. It is cut by a section plane perpendicular to the V.P. and parallel to and 12 mm away from one of its end generators. Draw its front view, *sectional top view and true shape of the section.*



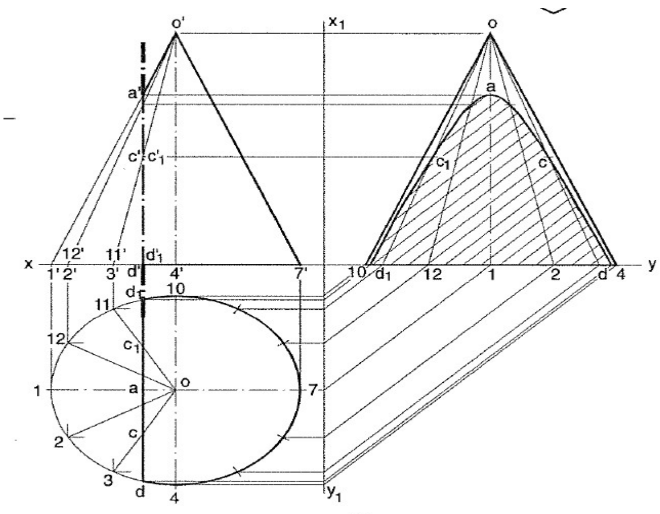
11. A cone, base 75 mm diameter and axis 80 mm long is resting on its base on the H.P. It is cut by a section plane perpendicular to the VP., inclined at 45° to the H.P. and cutting the axis at a point 35 mm from the apex. Draw its front view, sectional top view, sectional side view and true shape of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



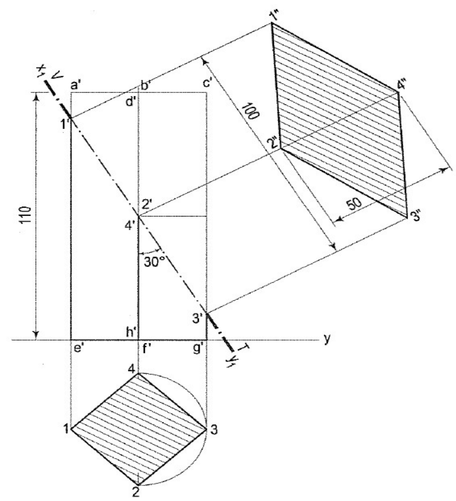
12. A cone, diameter of base 50 mm and axis 50 mm *long is resting on its base on the H.P. It is cut by a section plane perpendicular to the V.P., inclined at 75° to the H.P. and passing through the apex. Draw its front view, sectional top view and true shape of the section.*



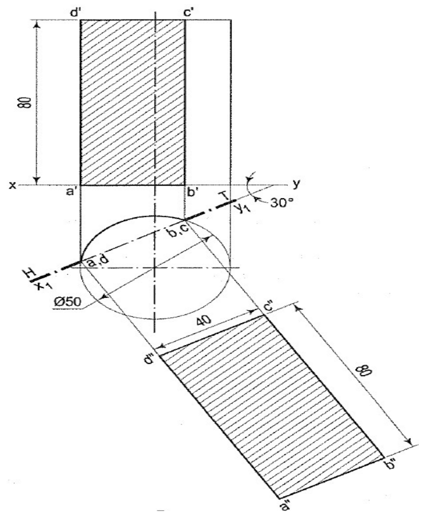
13. A cone, base 45 mm diameter and axis 55 mm long is resting on the H.P. on its base. It is cut by a section plane, perpendicular to both the H.P. and the V.P. and 6 mm away from the axis. Draw its front view, top view and sectional side view.



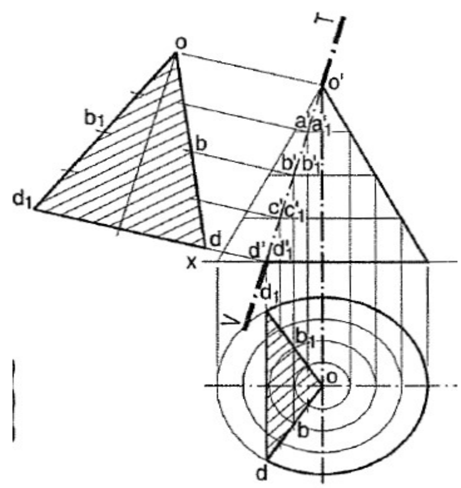
14. A square prism axis 110 mm long is *resting on its base in the H.P. The edges of the base are equally inclined to V.P. The prism* is *cut by an A.I.P. passing through the mid-point of the axis in such a way that the true shape of the section* is *rhombus having diagonals of 100 mm and 50 mm. Draw the projections and determine the inclination of A.I.P. with the H.P.*



15. A vertical cylinder 50 mm diameter is cut by an A. V.P. making 30° to the V.P. in such a way that the true shape of the section is a rectangle of 40 mm x 80 mm sides. Draw the projections and the true shape of the section.

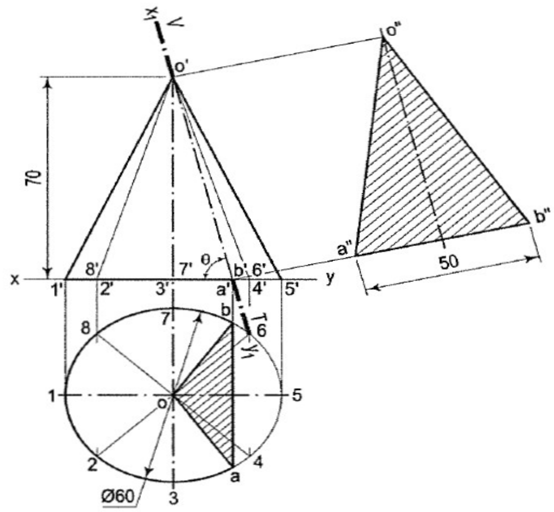


16. A cone, diameter of base 50 mm and axis 50 mm *long is resting on its base on the H.P. It is cut by a section plane perpendicular to the V.P., inclined at 75° to the H.P. and passing through the apex. Draw its front view, sectional top view and true shape of the section. Draw the projections of the cone and on it, show the line* V. *T. for the section plane.*

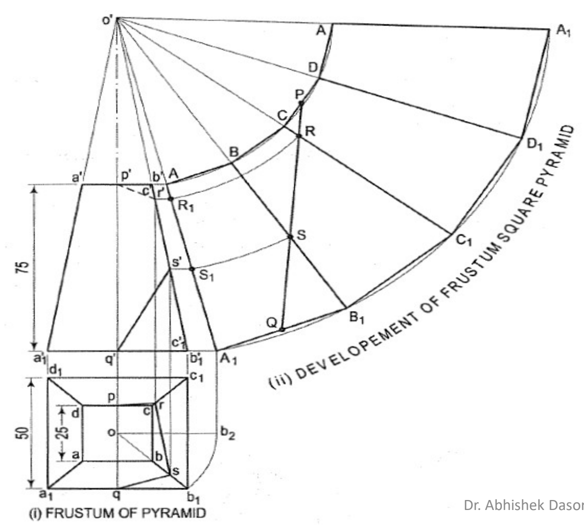


17. A cone, diameter of the base 60 mm and axis 70 mm long is resting on its base on the H.P. It is cut by an A.I.P. so that the true shape of the section is an isosceles triangle having 50 mm base. Draw the top view, the front view and the true shape of the section.

When a section plane passes through an apex of a cone and cuts the base of the cone, the true-shape of section is a triangle.



18. A frustum of a square pyramid has its base 50 mm side, top 25 mm side and height 75 mm. Draw the development of its lateral surface. Also, draw the projections of the frustum (when its axis is vertical and a side of its base is parallel to the V.P., showing the line joining the mid-point of a top edge of one face with the mid-point of the bottom edge of the opposite face, by the shortest distance.



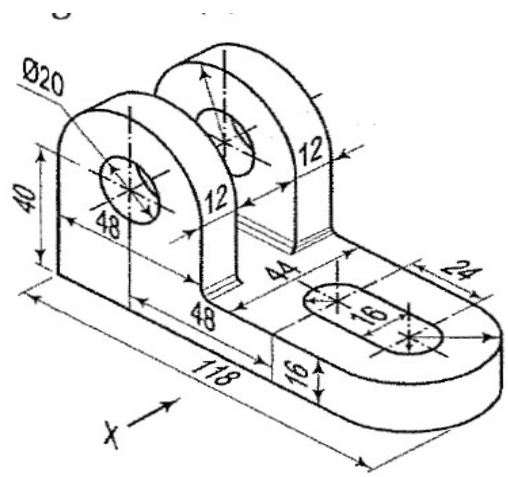
UNIT-VI

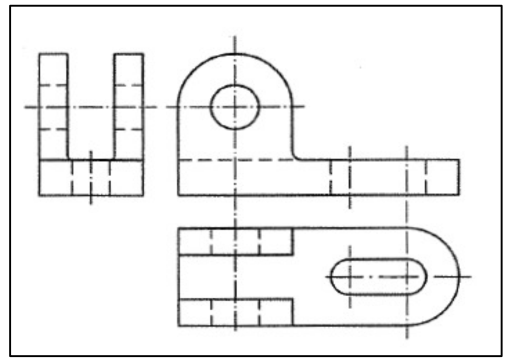
1. Introduction to Isometric projections/ views
2. Construction of isometric view/ projections of simple solids
3. Conversion of isometric views to orthographic views.
4. Projections – Construction of orthographic views to isometric

- When the projectors are parallel to each other and also perpendicular to the plane, the projection is called *orthographic 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.
- *Perspective projection* or perspective drawing is the representation of an object on a plane surface, called the *picture plane,* as it would appear to the eye, when viewed from a fixed position. In perspective projection, the eye is assumed to be situated at a definite position relative to the object. The vertical plane, which (in perspective) is called the picture plane, is placed between the object and the eye.
- An oblique projection like isometric projection is another method of pictorial projection. The oblique projection represents three dimensional object on the projection plane by one view only. This type of drawing is useful for making an assembly of an object and provides directly a production drawing (working drawing) of the object for the manufacturing purpose.

1. Draw the following views of the object shown pictorially in Figure.

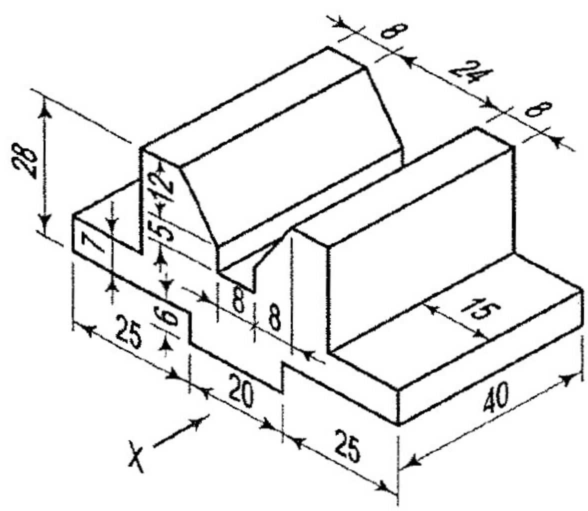
(i) Front view. (ii) Top view. (iii) Side view from the right..

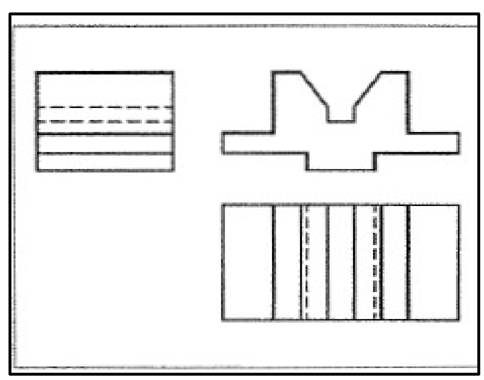




2. Draw the following views of the object shown pictorially in Figure.

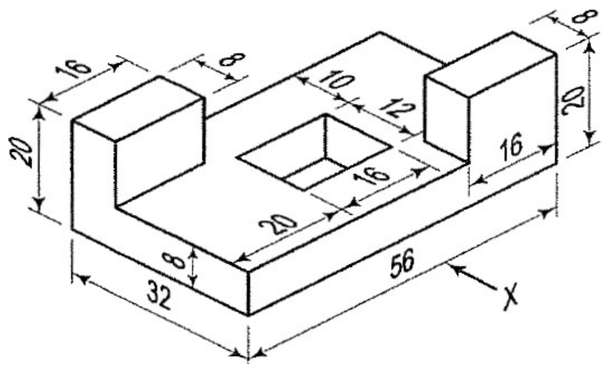
(i) Front view. (ii) Top view. (iii) Both side views.

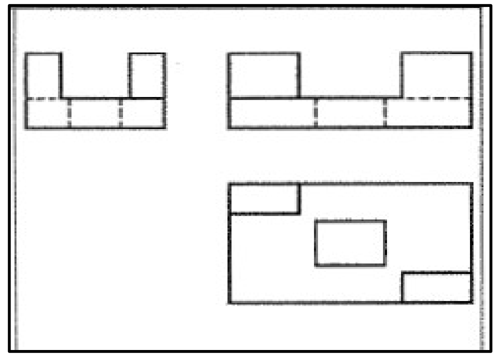




3. Draw the following views of the object shown pictorially in Figure.

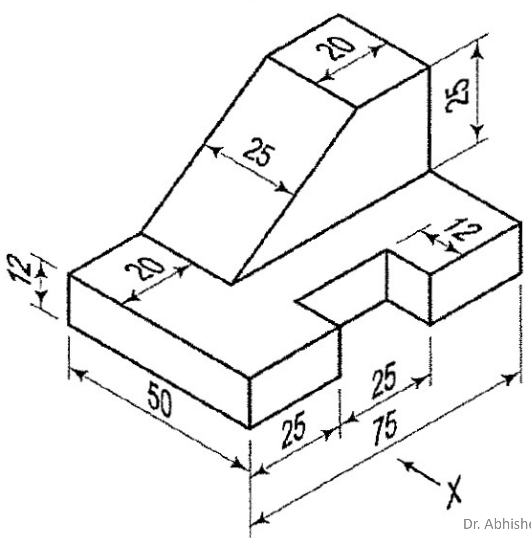
(i) Front view. (ii) Top view. (iii) Both side views.

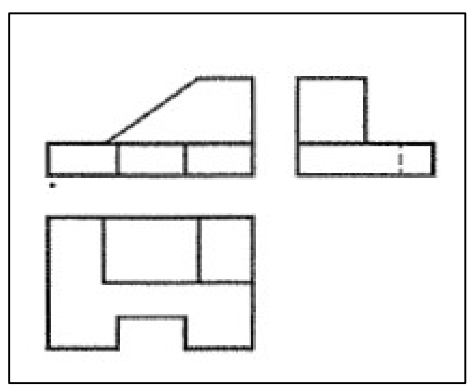




4. Draw the following views of the object shown pictorially in Figure.

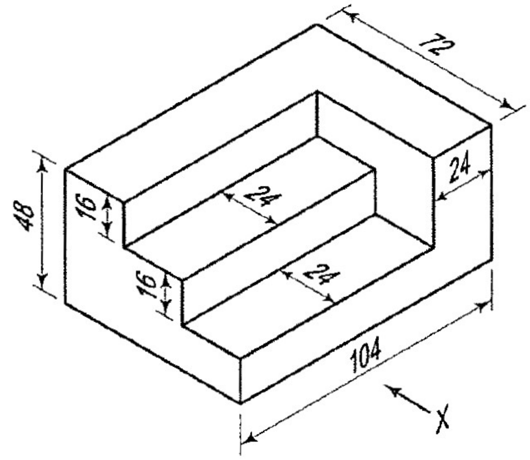
(i) Front view. (ii) Top view. (iii) Both side views.

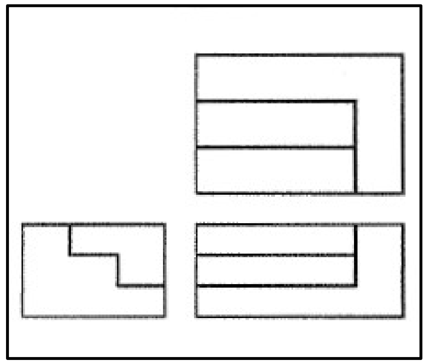




5. Draw the following views of the object shown pictorially in Figure.

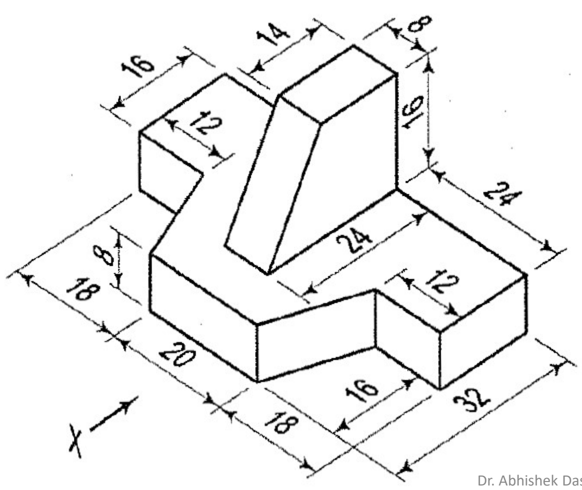
(i) Front view. (ii) Top view. (iii) Side view from the left. Use third angle projection method

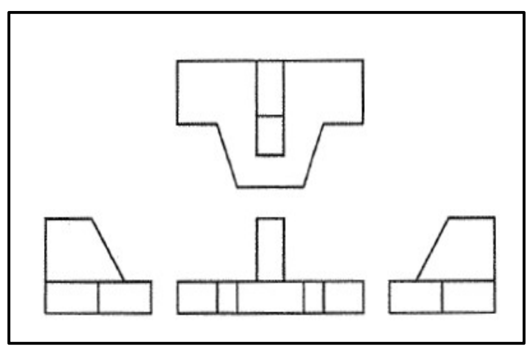




6. Draw the following views of the object shown pictorially in Figure.

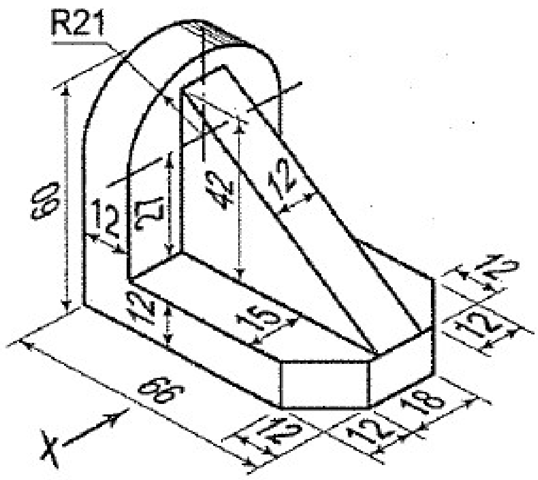
(i) Front view. (ii) Top view. (iii) Both side views. Use third angle projection method

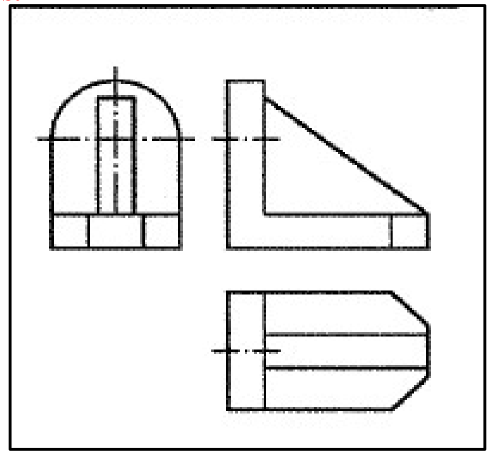




7. Draw the following views of the object shown pictorially in Figure.

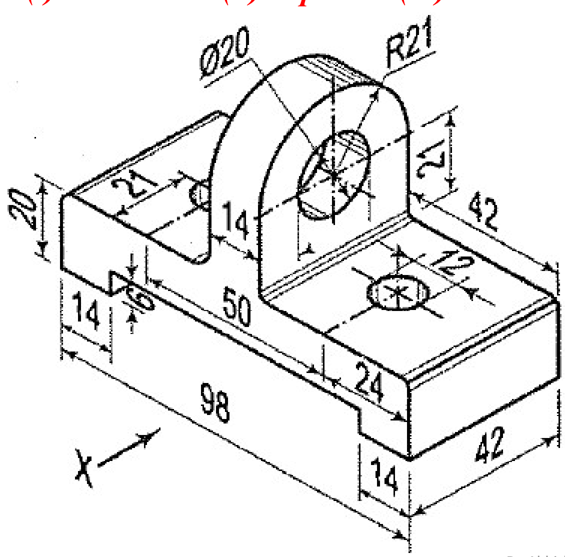
(i) Front view. (ii) Top view. (iii) Both side views.

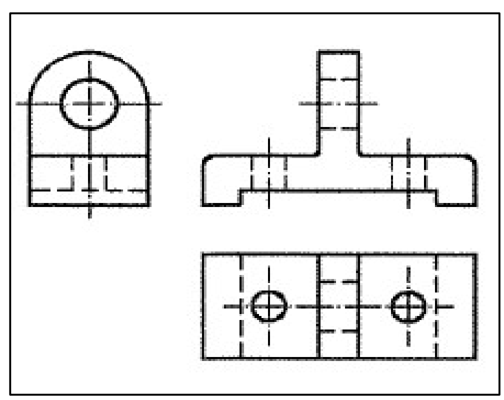




8. Draw the following views of the object shown pictorially in Figure.

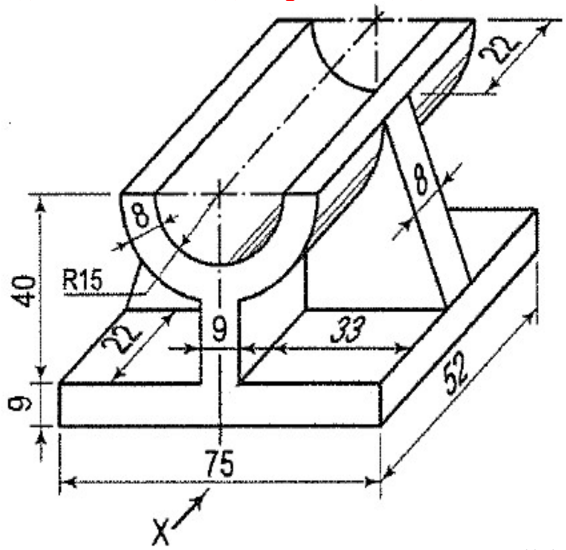
(i) Front view. (ii) Top view. (iii) Both side views.

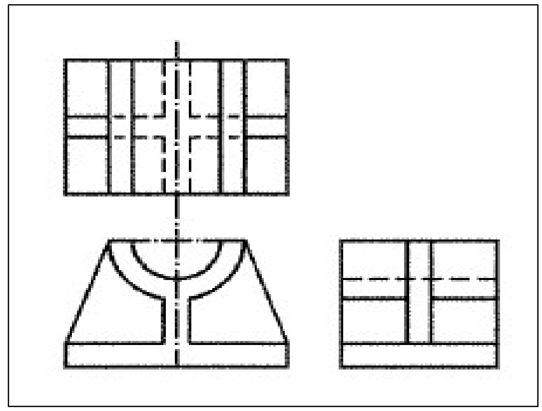




9. Draw the following views of the object shown pictorially in Figure.

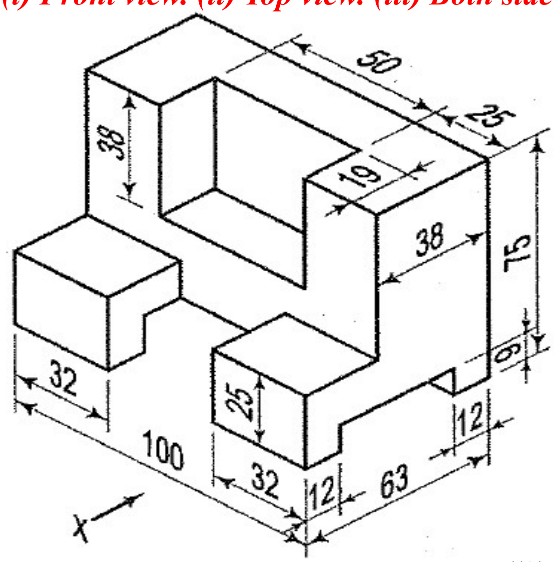
(i) Front view. (ii) Top view. (iii) Both side views.

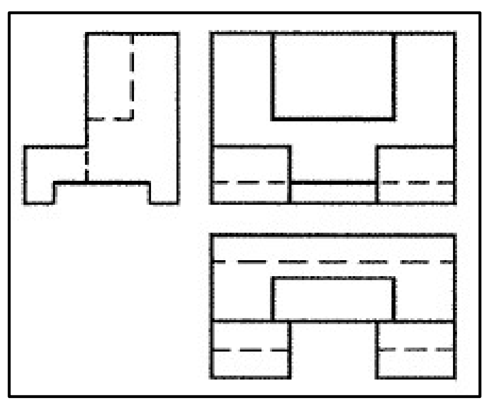




10. Draw the following views of the object shown pictorially in Figure.

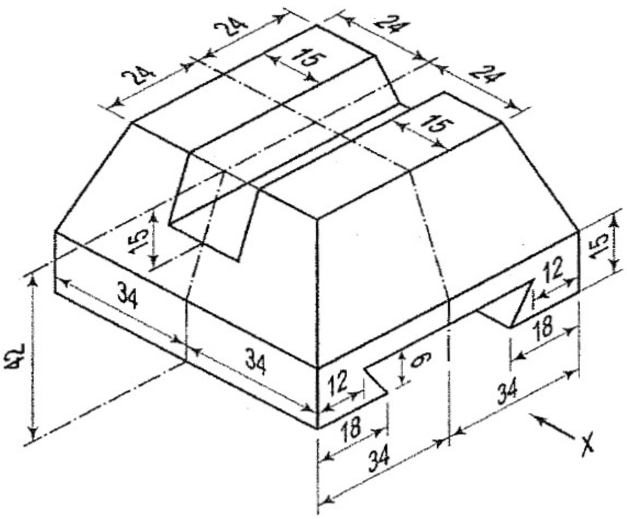
(i) Front view. (ii) Top view. (iii) Both side views.

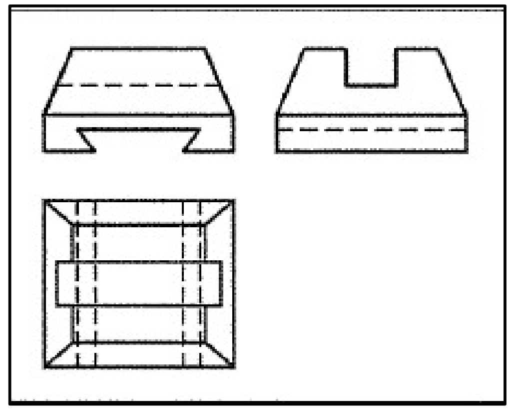




11. Draw the following views of the object shown pictorially in Figure.

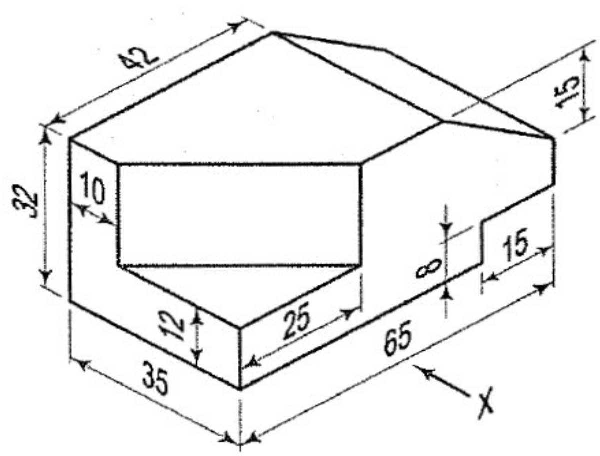
(i) Front view. (ii) Top view. (iii) Both side views.

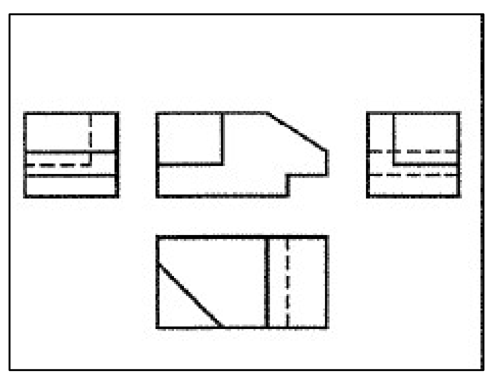




12. Draw the following views of the object shown pictorially in Figure.

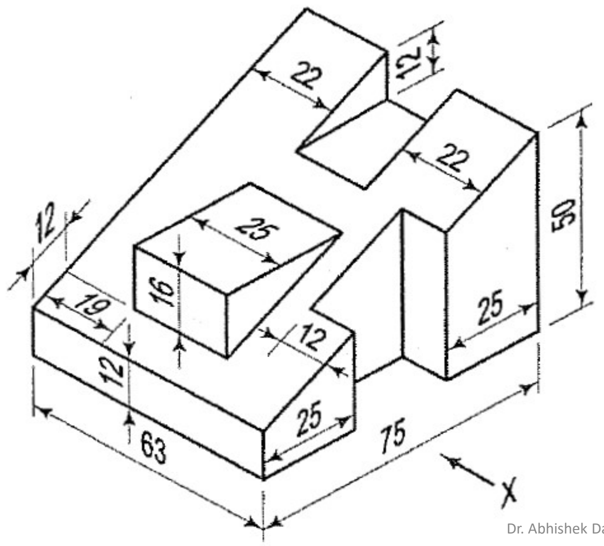
(i) Front view. (ii) Top view. (iii) Both side views.

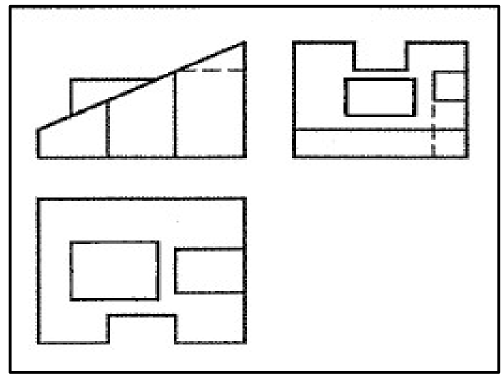




13. Draw the following views of the object shown pictorially in Figure.

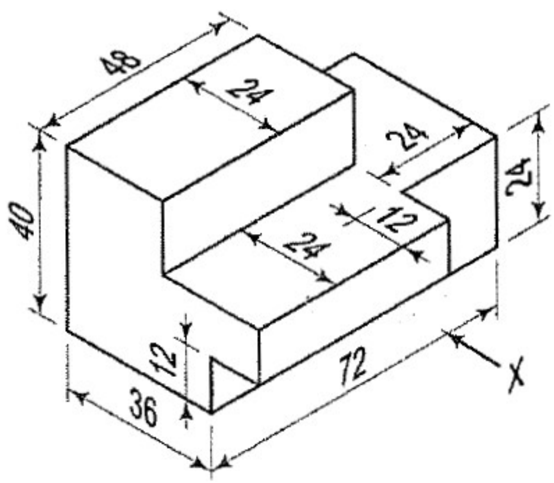
(i) Front view. (ii) Top view. (iii) Both side views.

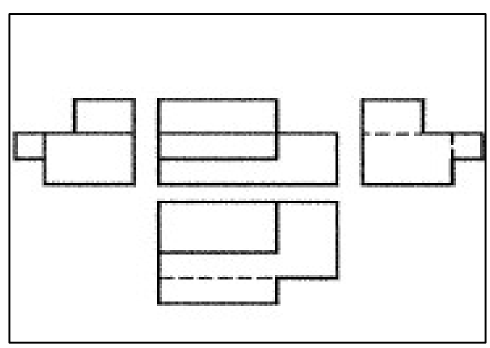




14. Draw the following views of the object shown pictorially in Figure.

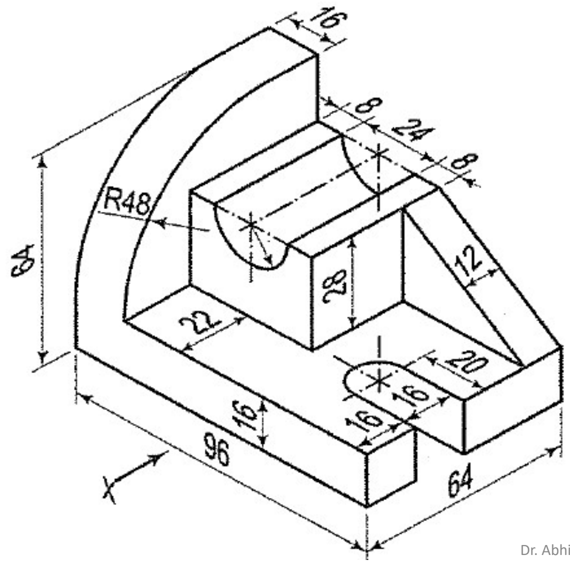
(i) Front view. (ii) Top view. (iii) Both side views.

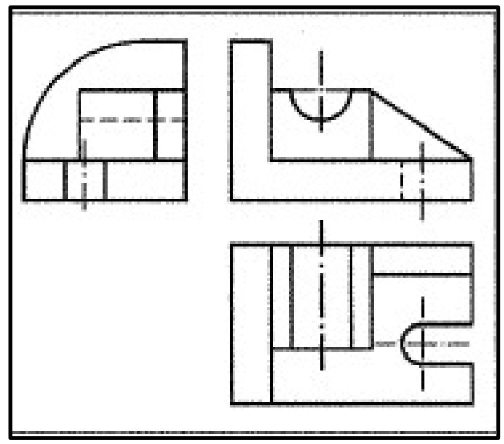




15. Draw the following views of the object shown pictorially in Figure.

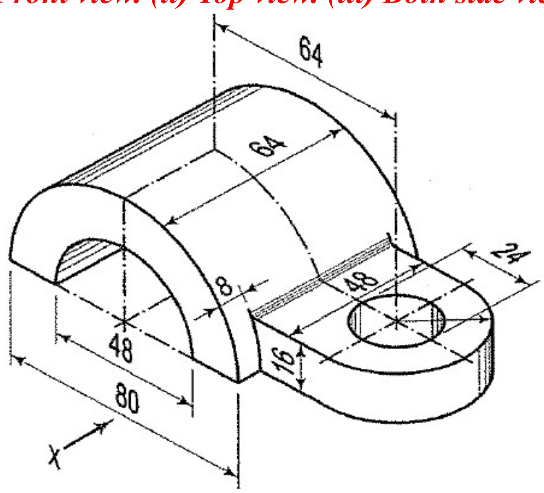
(i) Front view. (ii) Top view. (iii) Both side views.

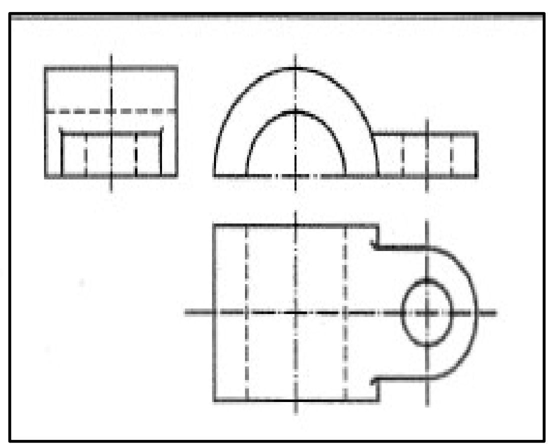




16. Draw the following views of the object shown pictorially in Figure.

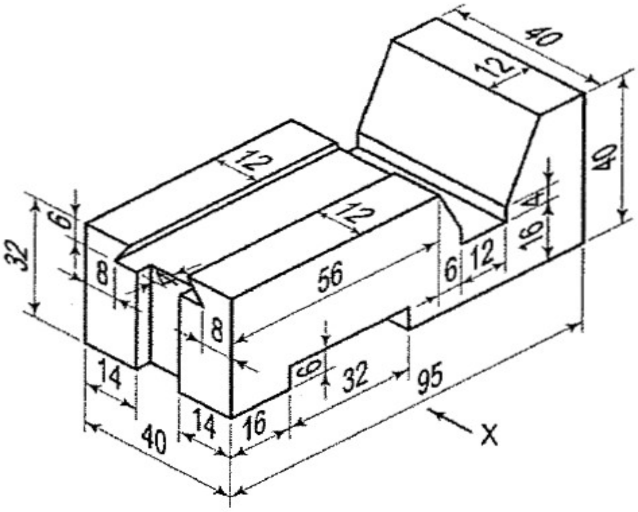
(i) Front view. (ii) Top view. (iii) Both side views.

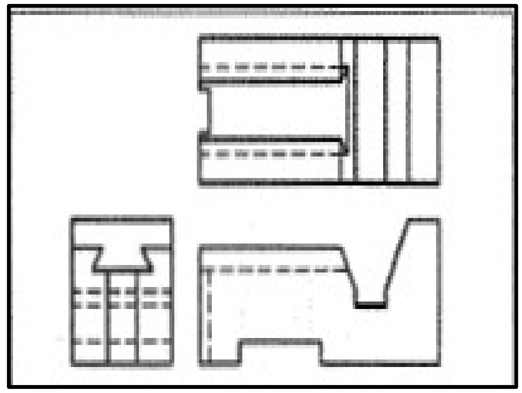




17. Draw the following views of the object shown pictorially in Figure.

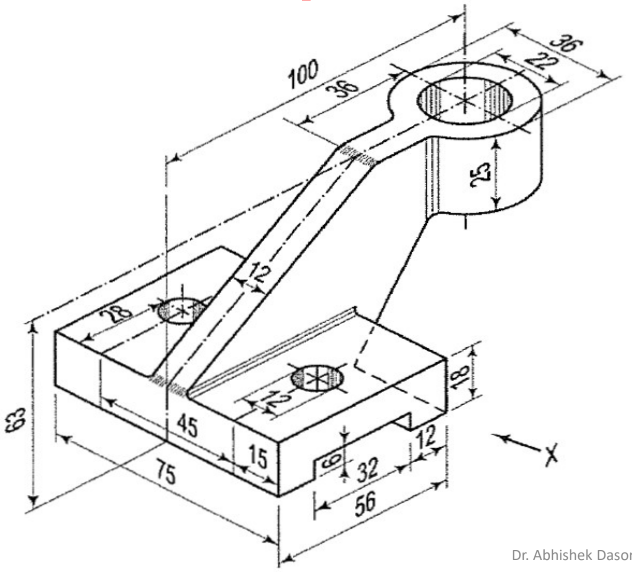
(i) Front view. (ii) Top view. (iii) Both side views.

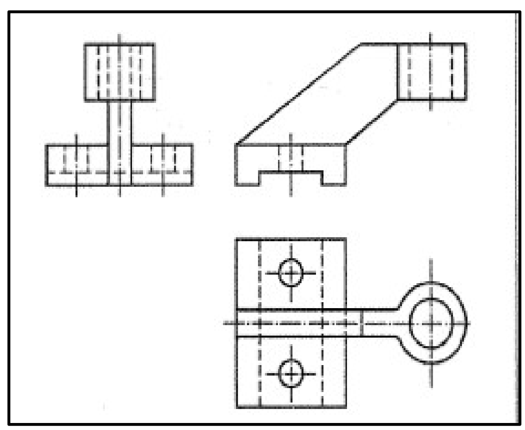




18. Draw the following views of the object shown pictorially in Figure.

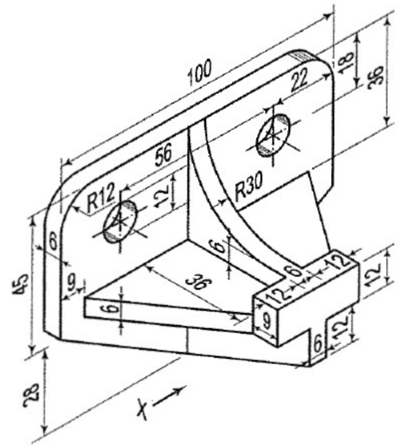
(i) Front view. (ii) Top view. (iii) Both side views.

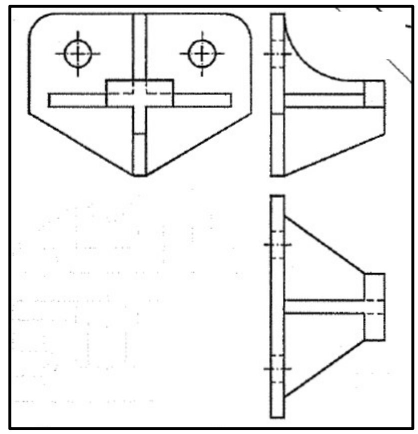




19. Draw the following views of the object shown pictorially in Figure.

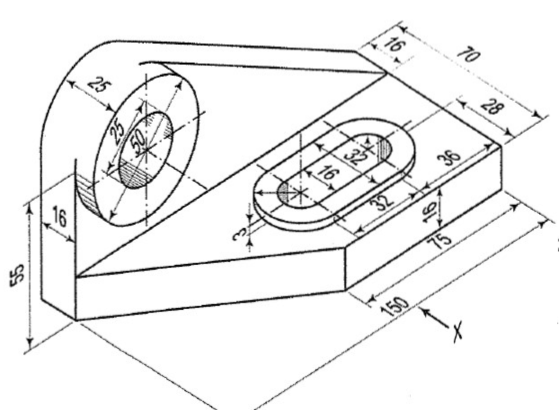
(i) Front view. (ii) Top view. (iii) Both side views.

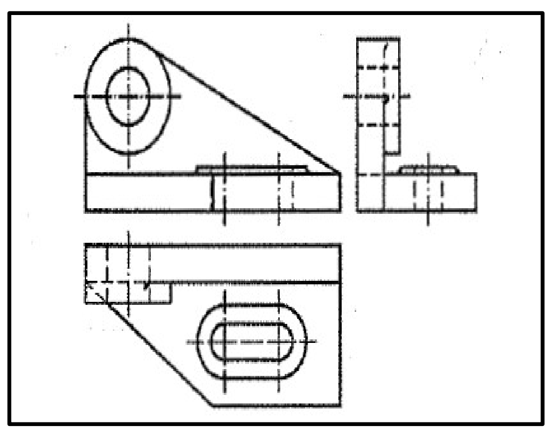




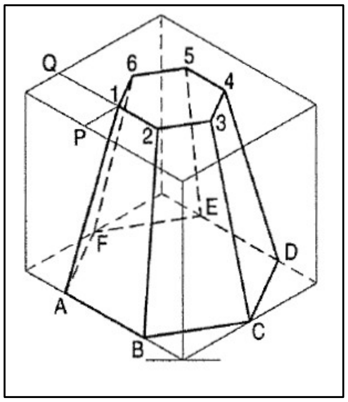
20. Draw the following views of the object shown pictorially in Figure.

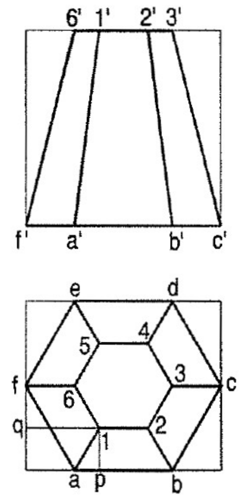
(i) Front view. (ii) Top view. (iii) Both side views.



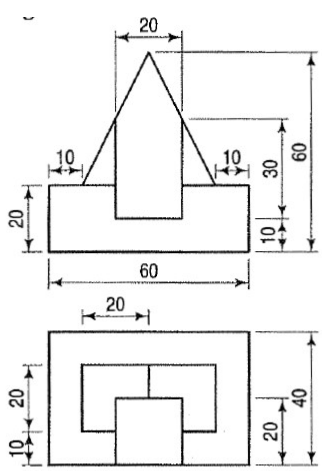


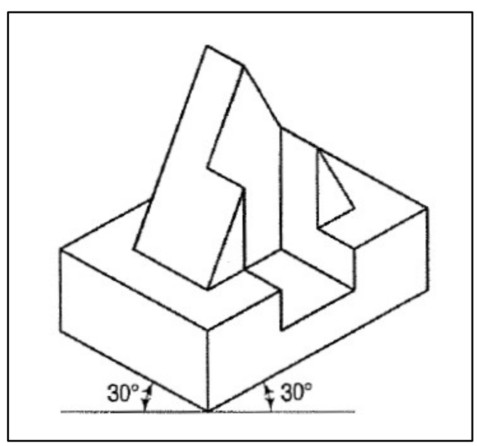
21. Draw the isometric view of the frustum of the hexagonal pyramid shown in fig.



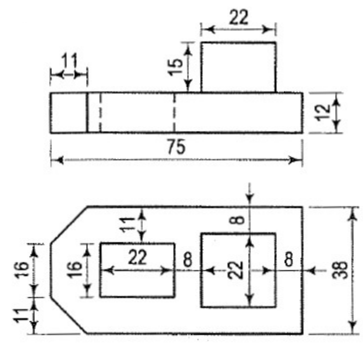


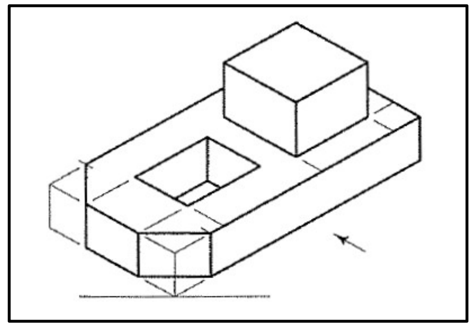
22. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.



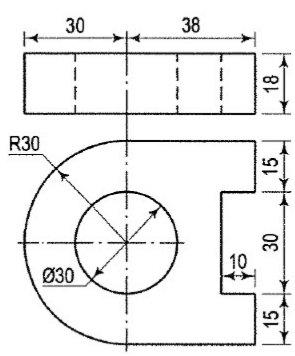


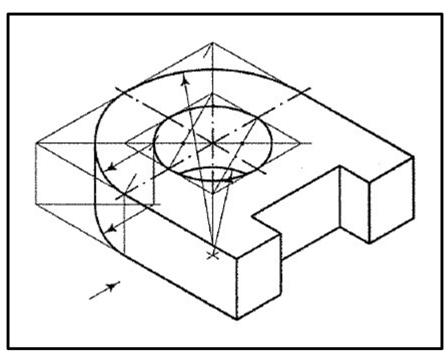
23. Draw the isometric view of the casting shown in two views in fig.



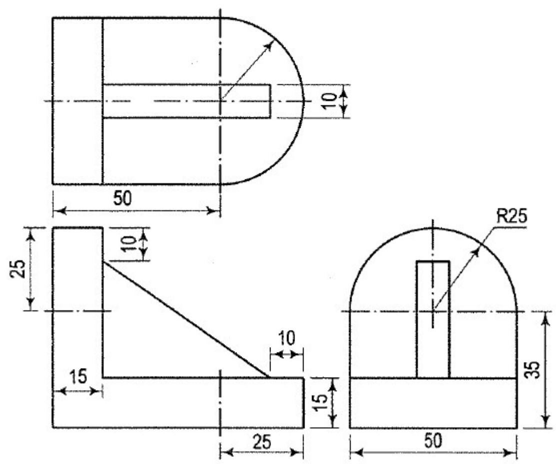


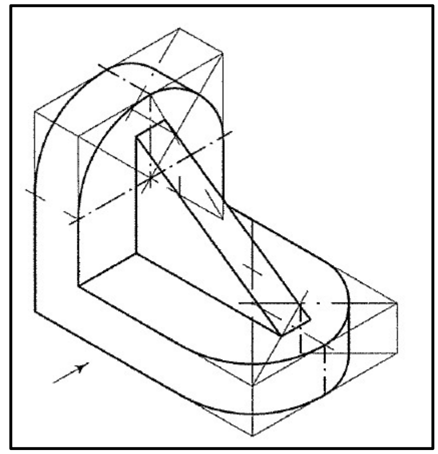
24. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.



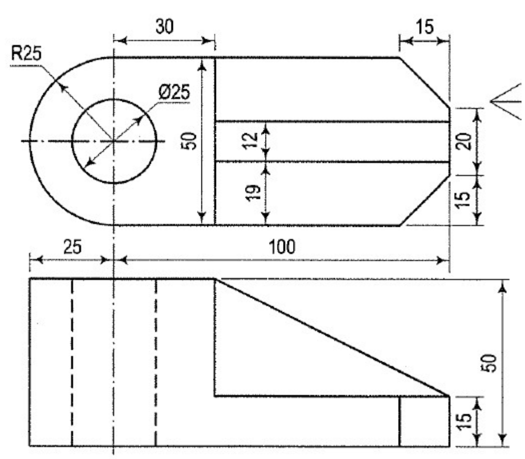


25. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.

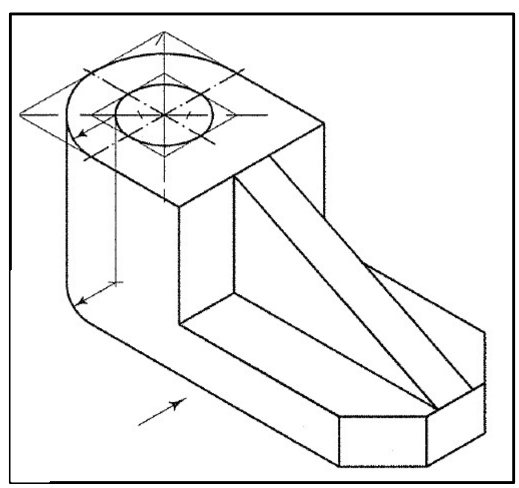




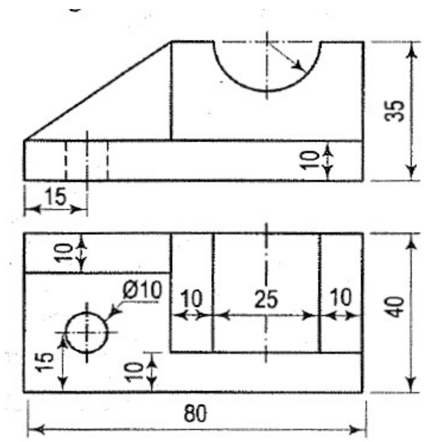
26. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.

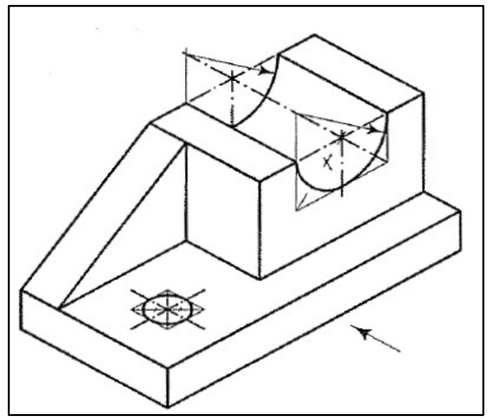


(Third-angle projection)

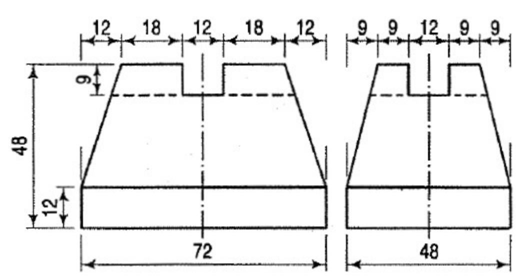


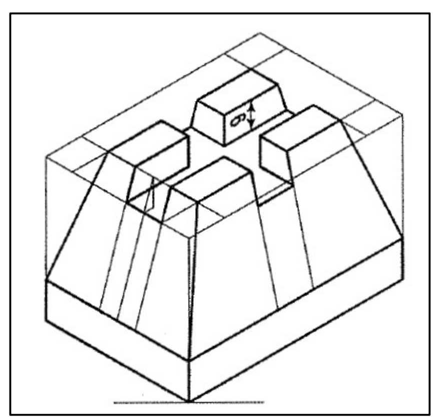
27. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.



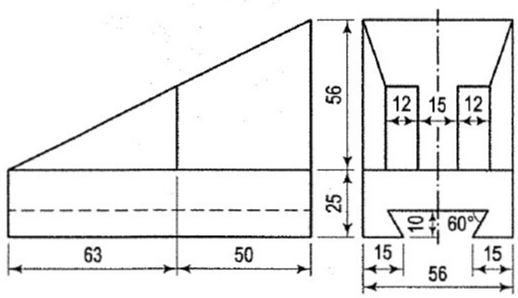


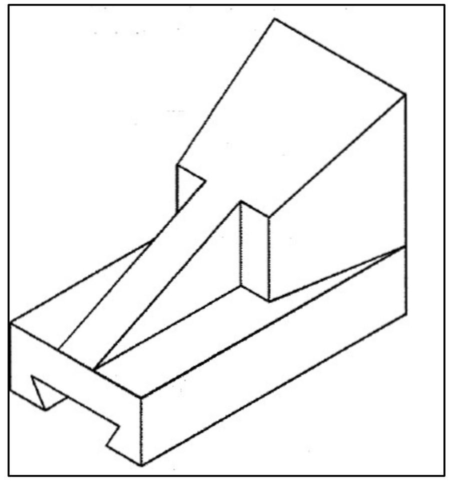
28. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.



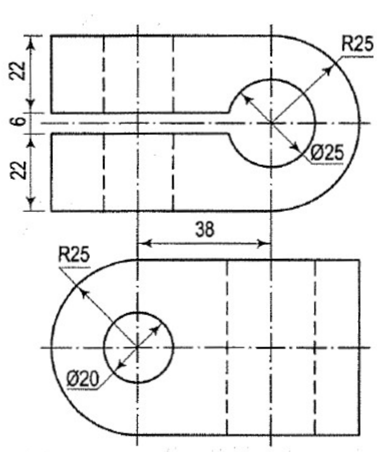


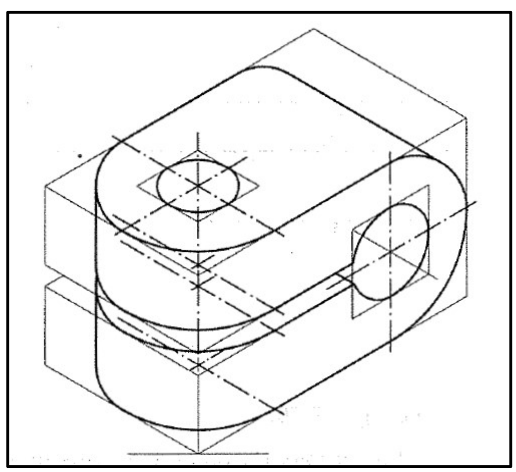
29. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.



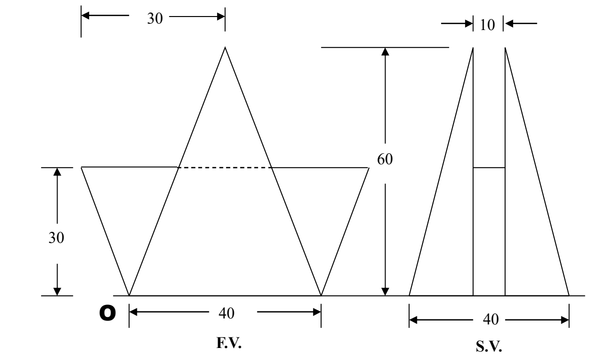


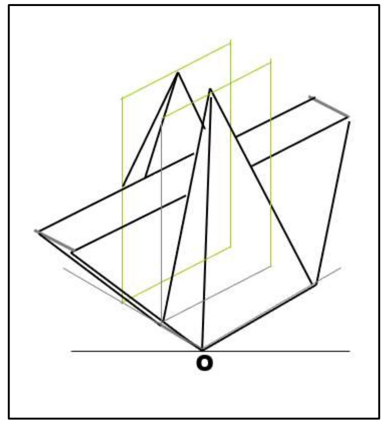
30. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.



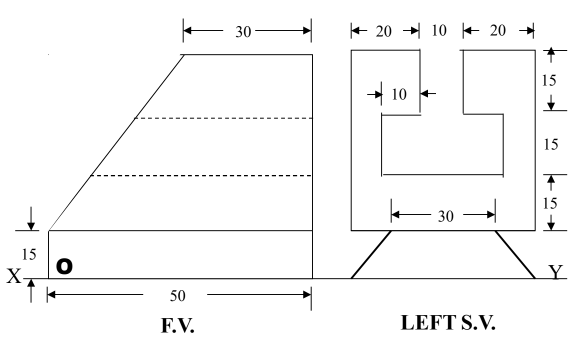


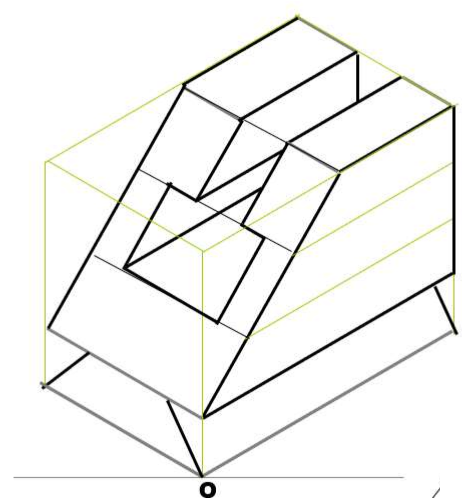
31. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.



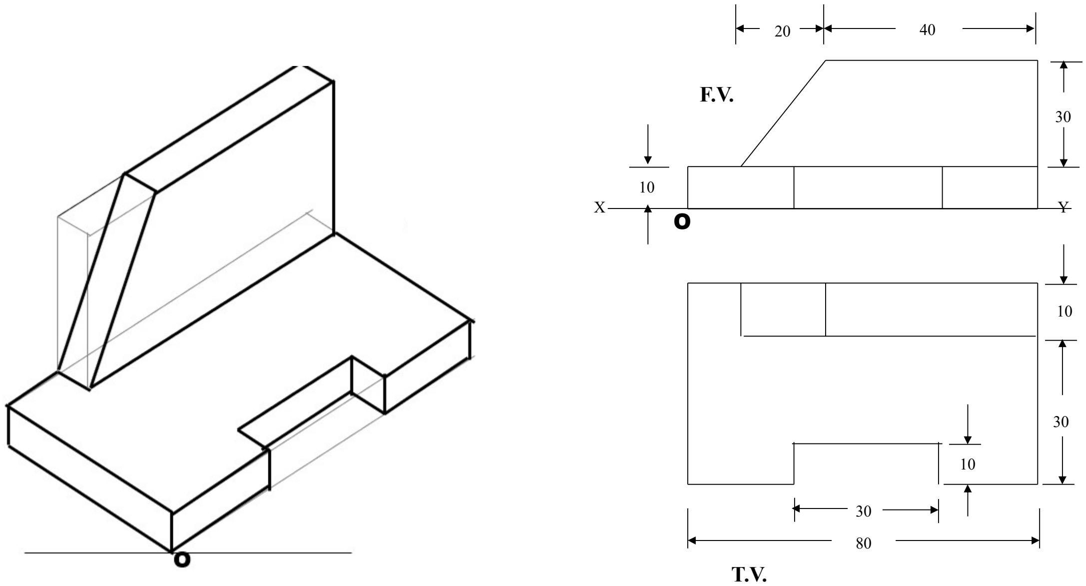


32. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.

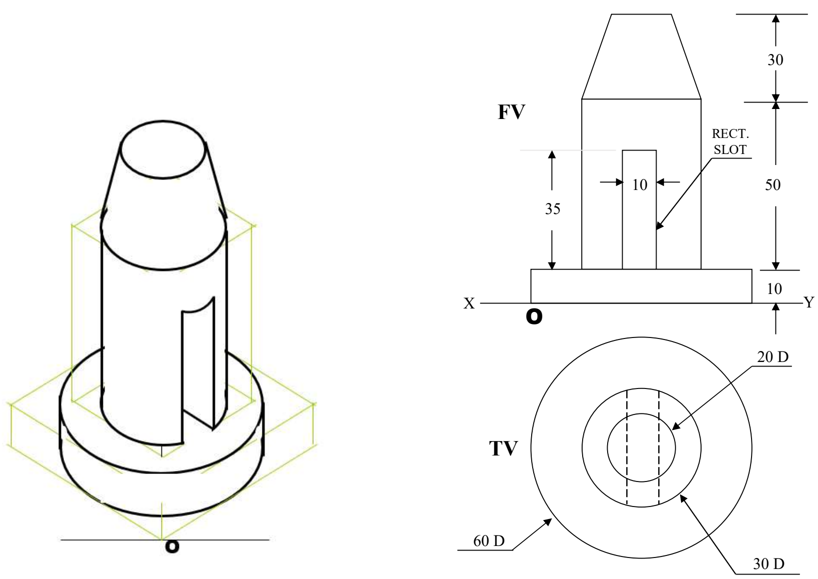




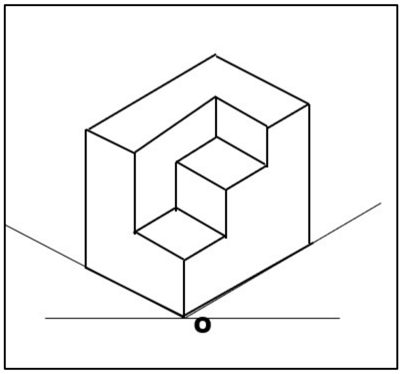
33. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.

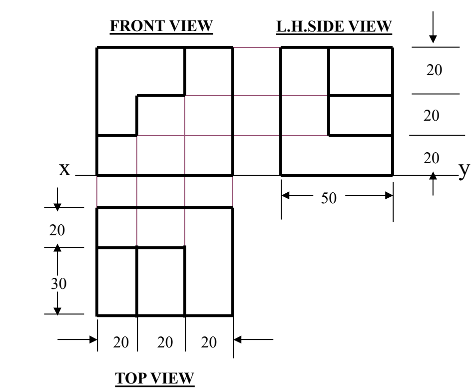


34. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.

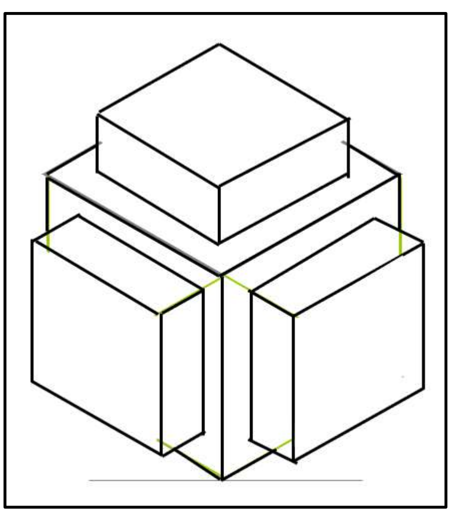


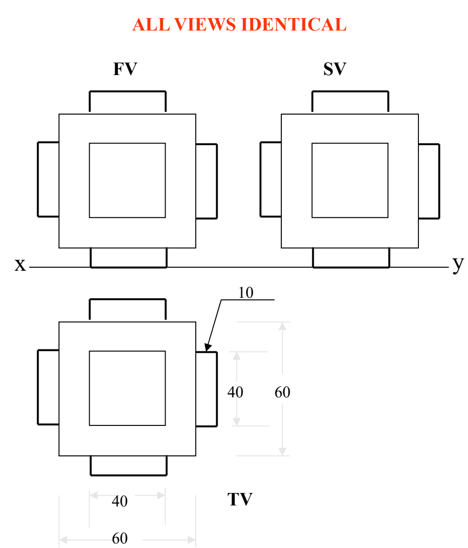
35. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.



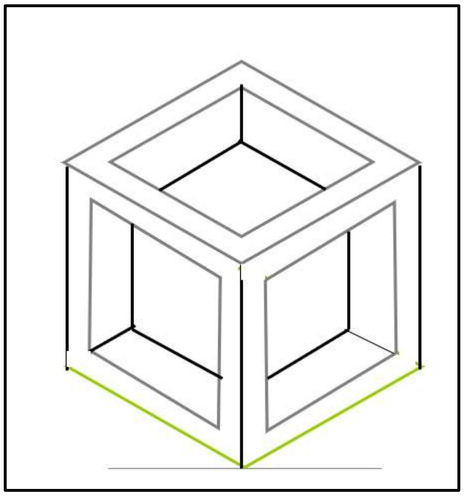


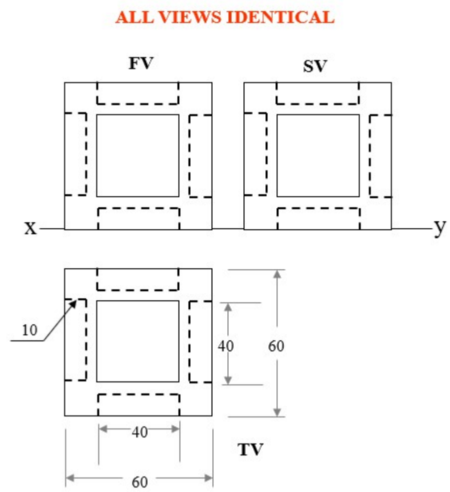
36. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.



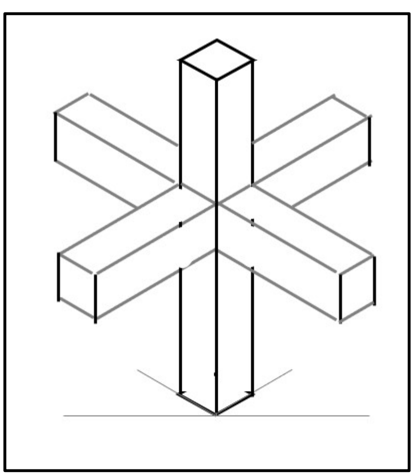


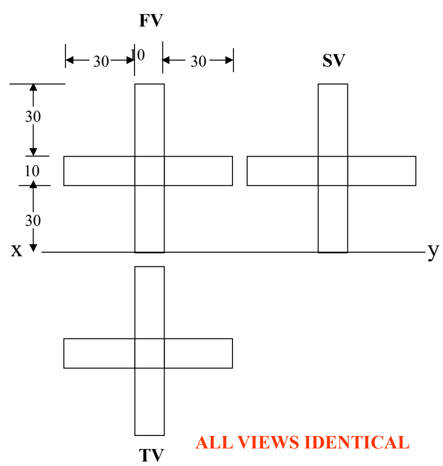
37. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.



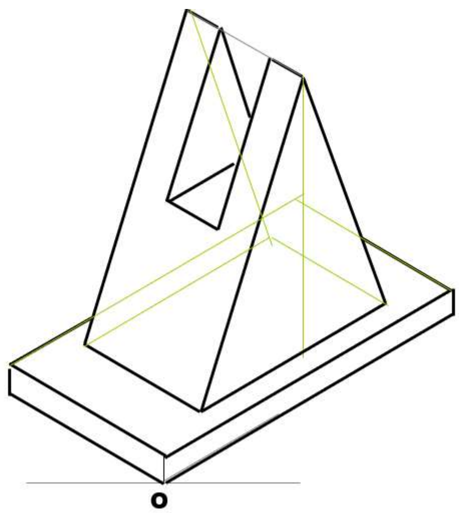


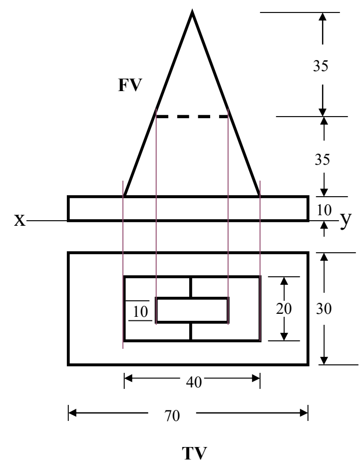
38. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.





39. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.





40. The orthographic projections of the object is shown in fig. Draw the isometric view of the object.