1. DIMENSIONING

1.1. INTRODUCTION

Dimensions are indicated on the drawing to define the size characteristics such as length, breadth, height, diameter, radius, angle and location of hole, slot, etc. They should be mentioned directly on the drawing to describe a component clearly and completely in its finished form. The Bureau of Indian standards in its bulletin IS 11669:1986 (reaffirmed 1999) recommends general principle of dimensioning in technical drawing

1.2. Dimensioning Terminology

Figure 1.1 shows the methodology of dimensioning a drawing. The terminologies related to the dimensioning are as follows:

1. **Dimension value:** It is a numerical value that is being assigned to the size, shape or location of the feature being dimensioned. They are expressed in a specific unit (preferably millimeters) on drawings with relevant information.
2. **Dimension** lines: These are thin continuous lines that show the extent and direction of the dimension. They should be placed 8 to 10 mm away from the outlines and should be placed uniformly 6 to 8 mm from each other. The dimension values are placed preferably near the middle of the dimension lines.
3. **Projection lines:** These are the thin continuous lines stretched out from the outlines for dimensioning and extended 2 to 3 mm beyond the dimension lines. They should be drawn in a direction perpendicular to the feature to be dimensioned. Projection lines and dimension lines should not cross other lines,
4. **Leaders or pointer lines:** These are the lines referring to a feature and notes. It is executed using the thin continuous lines and terminated by arrow heads
5. **Arrowheads:** Usually, arrowheads are used for the termination of dimension lines. They may be open at a convenient angle of 30° to 90°, closed blank or closed filled as shown in Fig

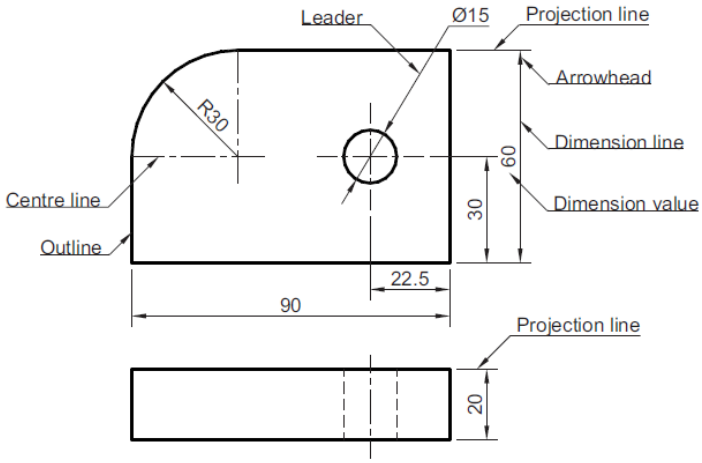


Fig1.1 dimensioning terminology

1.3. PLACEMENT OF DIMENSIONS

Dimensions should be placed on the view which shows the relevant features more clearly. The two recommended systems of placing the dimensions are as follows:

a. Aligned System:

1. **Linear dimensioning** all dimension values are placed above the dimension lines as shown in Fig. 1.2 .The values can be read from the bottom or the right-hand edges of the drawing sheet

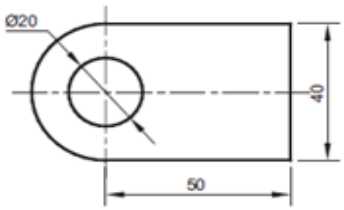


FIG. 1.2: Aligned system for linear dimensioning

2. Angular dimensioning: Angular dimensions and their deviations are dimensioned in the same manner as that of linear dimensions. Figure 1.3

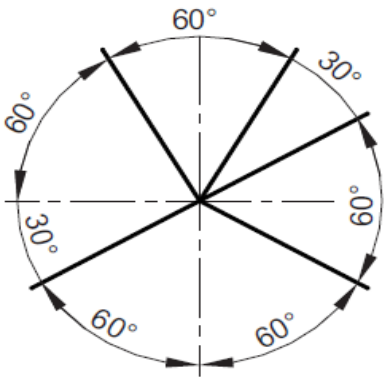


FIG. 1.3: Aligned system for Angular dimensioning

b. Unidirectional System

1. **Linear dimensioning**: All dimension values are placed upright as shown in Fig.1.4, so that they may be read from the bottom edge of the drawing sheet. For inserting a dimension value, the dimension line is broken at the middle

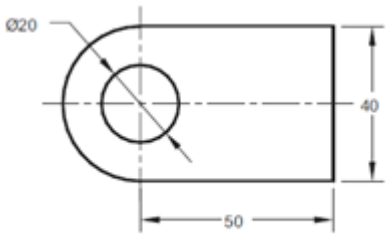


FIG1.4:nidirectional system for linear dimensioning

2. Angular dimensioning: Angular dimensions and their deviations are dimensioned in the same manner as that of linear dimensions. Fig.1.5. suggests the correct orientation and method for writing dimension values

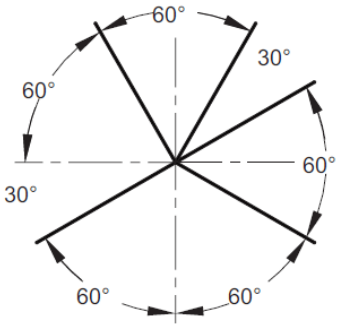
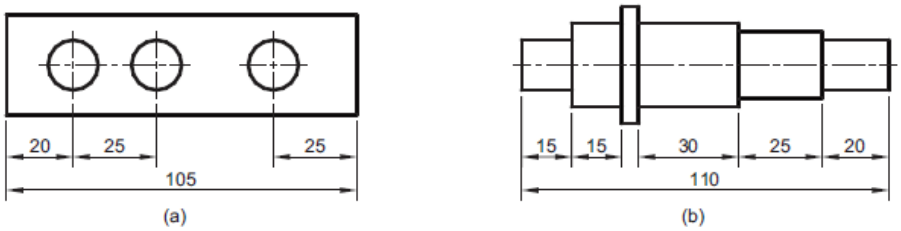


Fig.1.5:Unidirectional system for angular dimensioning

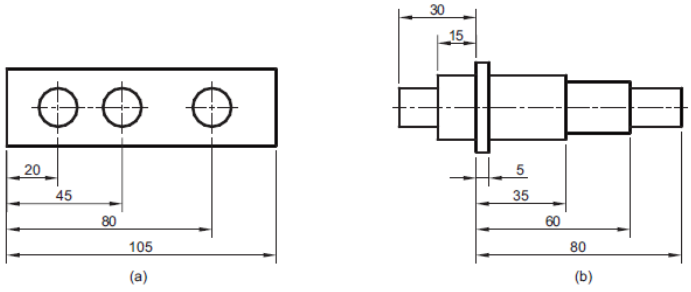
1.5. ARRANGEMENT OF DIMENSIONS

a. Continuous or Chain Dimensioning



(a) *and* **(b)** *Continuous or chain dimensioning*

b. Progressive or parallel dimensioning.



(a) *and* **(b)** *Progressive or parallel dimensioning*

2. ORTHOGRAPHIC PROJECTIONS

2.1 INTRODUCTION

ORTHO means RIGHT ANGLE

GRAPHIC means DRAWING

ORTHO GRAPHIC means RIGHT ANGLE DRAWING

When the projectors are perpendicular to the plane on which the projection is obtained and are also parallel to each other, it is known as *orthographic projection*. It is the projection system that engineers use for all type of manufacturing and construction drawings**.**

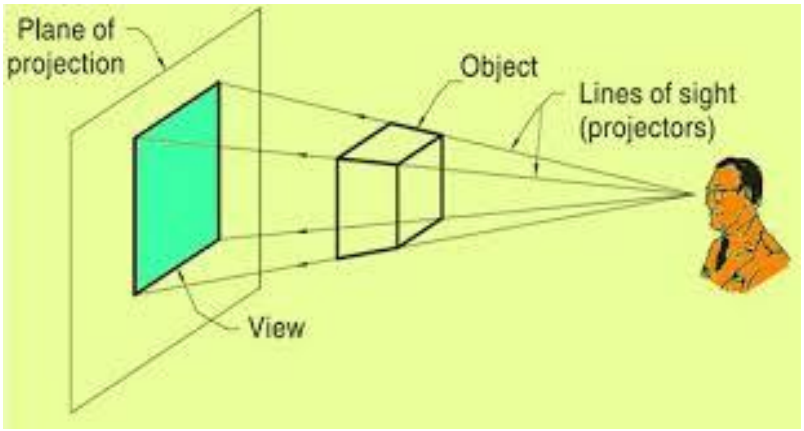


Fig.2.1

2.2. TERMINOLOGY:

For multi views drawing, the following terms are used frequently.

1. **Vertical plane (V.P):**
   A vertical plane, also known as Front Reference Plane, is assumed to be placed vertically and denoted by V.P.
2. **Horizontal Plane (H.P):**
   Horizontal plane is also known as horizontal reference plane, is assumed to be placed horizontally and denoted by H.P.

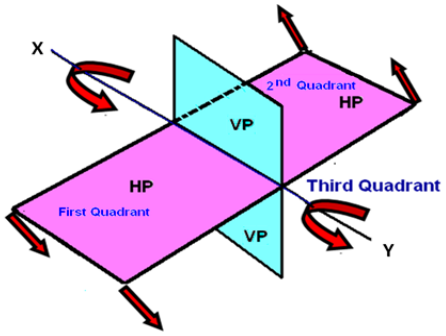


Fig.2.2: Principles of Quadrants

3. **PROFILE PLANE (P.P):**
   The plane perpendicular to both the principle planes is known profile plane. The plane on the right end of the principle plane is known as right profile plane, while the plane on the left end of the principle planes is known as the left profile plane.
4. **REFERENCE PLANE (XY):**
   The line of intersection between the principle planes is the known as the reference line. It is also popularity called an XY
5. **FRONT VIEW (F.V):**
   The view of an object obtained by observing it from the front and drawn on the V.P., is known as front view (F.V) or elevation.
6. **TOP VIEW (T.V):**
   The view of an object obtained by observing it from the top and drawn on the H.P., is known as top view (T.V) or plan.
7. **SIDE VIEW (S.V):**
   The view of an object obtained by observing it from the left hand side or right hand side drawn on profile plane is known as side view.

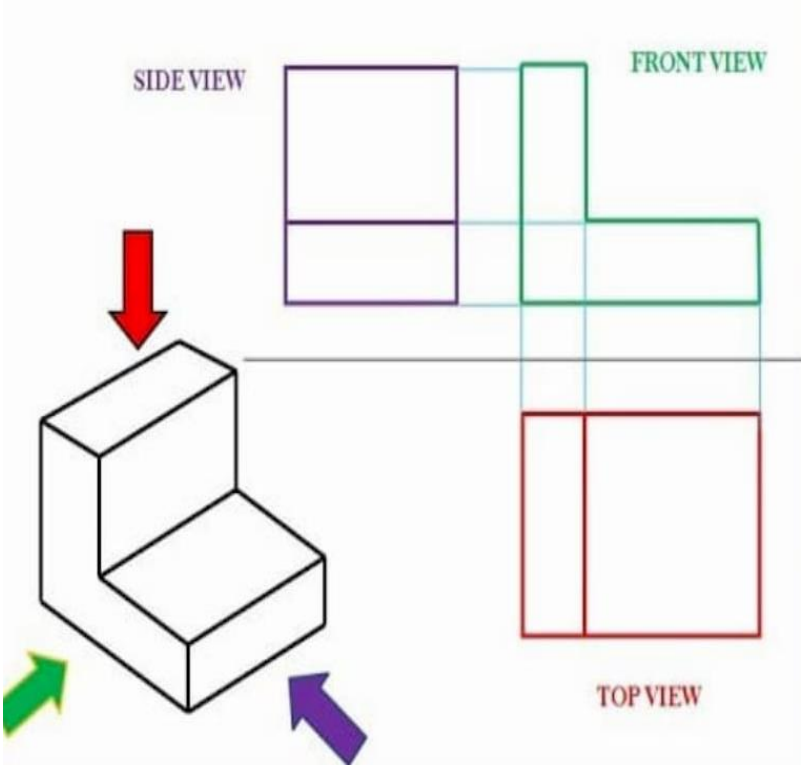


Fig.2.3:

2.3 .PRINCIPLES OF QUADRANTS

1. **Frist Quadrant:** It is above H.P. and in front of V.P.
2. **SECOND QUADRANT:** It is above H.P. and behand V.P.
3. **THIRD QUADRANT:** It is below H.P. and behand V.P.
4. **FORTH QUADRANT:** It is below H.P. and in front of V.P

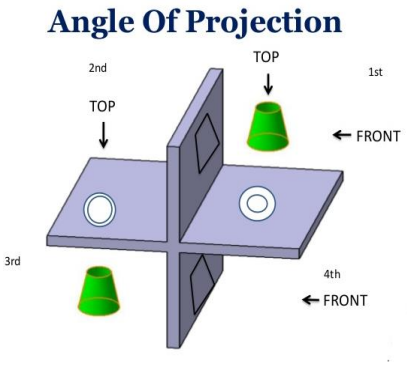


Fig.2.3:

2.4. FIRST ANGLE PROJECTION:

The features of first angle projections are

1. The object lies in the first angle i.e. in front of V.P. and above the H.P.
2. The object lies between the observer and plane of projection.
3. The top view is drawn below the front view.
4. The left hand side view is drawn to the right side of the front view.
5. The right hand side view is drawn to the left side of the front view.
6. Symbol of first angle projection

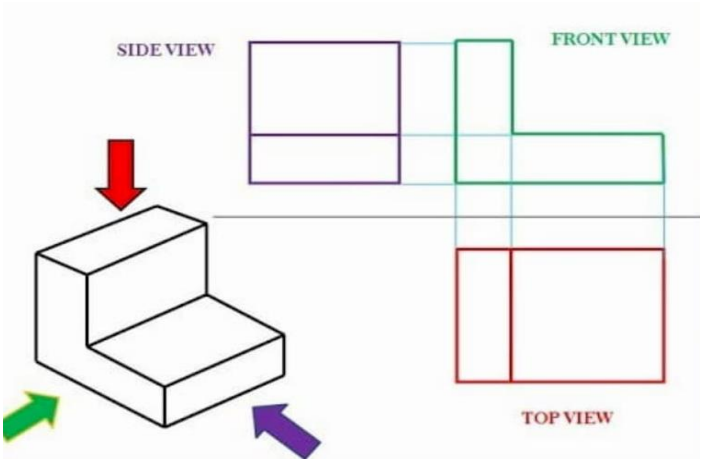


Fig.2.4.

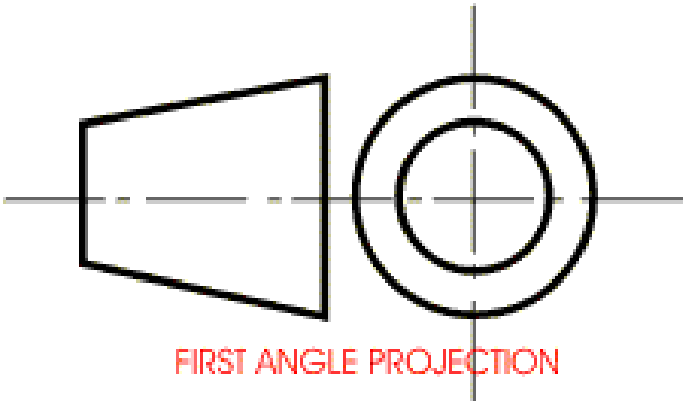


Fig.2.5.

2.5. THIRD ANGLE PROJECTION:

The features of third angle projection are

1. The object lies in the third angle i.e. in behind the V.P. and below the H.P.
2. The plane of projection lies between the object and observer.
3. The top view is drawn above the front view.
4. The left hand side view is drawn to the left side of the front view.
5. The right hand side view is drawn to the right side of the front view

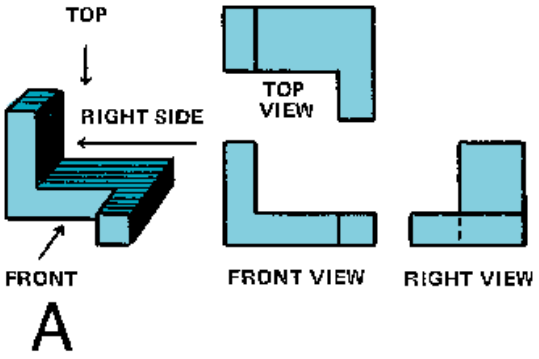


Fig.2.6.

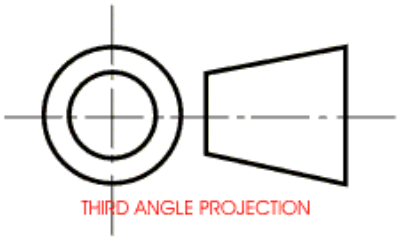


Fig.2.7.

2.6. PROJECTIONS OF POINTS:

- A solid is formed by three dimensions measured in three mutually perpendicular directions.
- If one of the dimensions is made zero, the object is converted into a 2-D plane surface.
- If one more dimensions is also reduced to zero, the plane is converted into a line.
- Finally, the remaining dimension is also removed, the line is of zero length and became a point.
- Therefore a point in 3-D geometry is the smallest dimensionless size of a solid.

2.7. POINT IN SPACE:

- A point may lie in space, in any one of the four quadrants formed by two reference planes H.P. and V.P. A point is represented by a dot in the drawing.

2.8. LOCATIONS OF A POINTS:

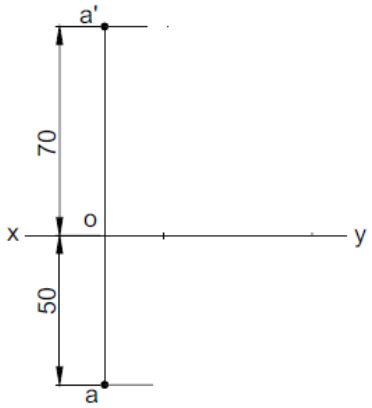
- When a point lies in the **First Quadrant**. It will be **above H.P. and in front of V.P**.
- When a point lies in the **Second Quadrant**. It will be **above H.P. and behind V.P**.
- When a point lies in the **Third Quadrant**. It will be **below H.P. and behind V.P**.
- When a point lies in the **Fourth Quadrant**. It will be **below H.P. and in front of V.P**.

2.9. CONVENTIONAL REPRESENTATION:

- The actual position of a point is designated by a capital letters. i.e. **A, B, C, P, Q, R, S… etc.**
- The front view of a point is conventionally represented by a small letters with dashes. i.e. **a', b', c', p', q', r'…etc.**
- The side view of a point is conventionally represented by a small letters with double dashes. I.e. **a'', b'', c'', p'', q'', r''…etc.**
- The intersection of the reference planes is a line known as the reference line. If the donated as **XY**. The reference line is drawn by **thin line**
- The line which contact the front view and the top view is called the projection line. It is drawn by **thin line**. The projection line is always perpendicular the reference line **(XY).**

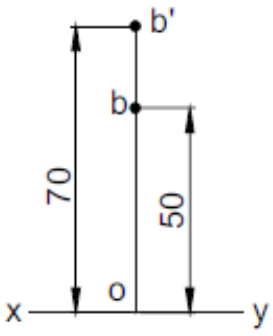
Problem 1. Point A is 70mm above H.P. and 50mm in front of V.P. Draw its projections
Construction:

1. Draw a reference line XY.
2. Draw a projector perpendicular to the XY.
3. Mark front view a' on the projector 70mm above XY.
4. Mark the top view a on the projector 50mm below XY.



Problem 2. Point B is 70mm above H.P. and 50mm in behind the V.P. Draw its projections
Construction:

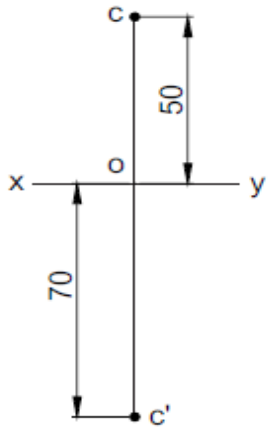
1. Draw a reference line XY.
2. Draw a projector perpendicular to the XY.
3. Mark front view b' on the projector 70mm above XY.
4. Mark the top view b on the projector 50mm above XY.



Problem 3. . Point C is 70mm below H.P. and 50mm in behind the V.P. Draw its projections

Construction:

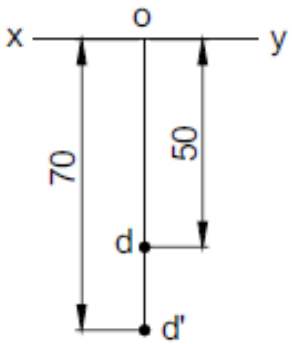
1. Draw a reference line **XY.**
2. Draw a projector perpendicular to the **XY.**
3. Mark front view **c'** on the projector 50mm below XY**.**
4. Mark the top view **c** on the projector 70mm above XY**.**



Problem 4. . Point D is 70mm below H.P. and 50mm in front of V.P. Draw its projections

Construction:

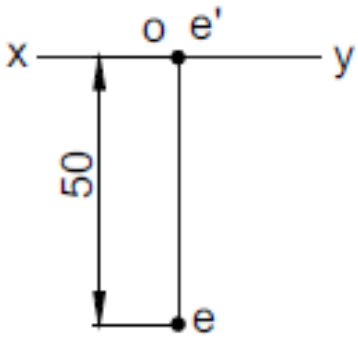
1. Draw a reference line **XY.**
2. Draw a projector perpendicular to the **XY.**
3. Mark front view **d'** on the projector 70mm below XY**.**
4. Mark the top view **d** on the projector 50mm below XY**.**



Problem.5. Point E lies on H.P and 50mm in front of V.P. Draw its projections.

Construction:

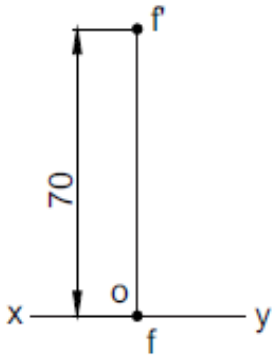
1. Draw a reference line **XY.**
2. Draw a projector perpendicular to the **XY.** Line.
3. Mark front view **e'** on **XY.** Line.
4. Mark the top view **e** on the projector 50mm below XY**.** Line.



Problem.6. Point F lies on V.P and 70mm above the H.P. Draw its projections

Construction:

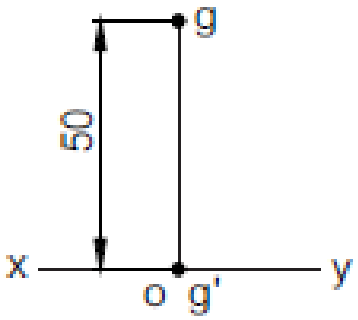
1. Draw a reference line **XY.**
2. Draw a projector perpendicular to the **XY.** Line.
3. Mark front view **f'** on the projector 70mm above the **XY.** Line.
4. Mark the top view **f** on **XY.** Line



Problem .7. Point G lies on H.P and 50mm behind the V.P. Draw its projections.

Construction:

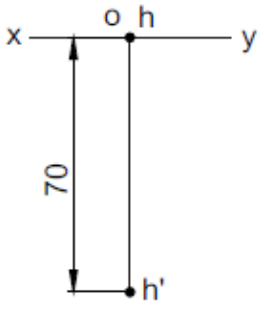
1. Draw a reference line **XY.**
2. Draw a projector perpendicular to the **XY.** Line.
3. Mark front view **g'** on **XY.** Line.
4. Mark the top view **g** on the projector 50mm above XY**.** Line



Problem.8. Point H lies on V.P and 70mm below H.P. Draw its projections.

Construction:

1. Draw a reference line **XY.**
2. Draw a projector perpendicular to the **XY.** Line.
3. Mark front view **h'** on the projector 70mm above the **XY.** Line.
4. Mark the top view **h** on **XY.** Line.



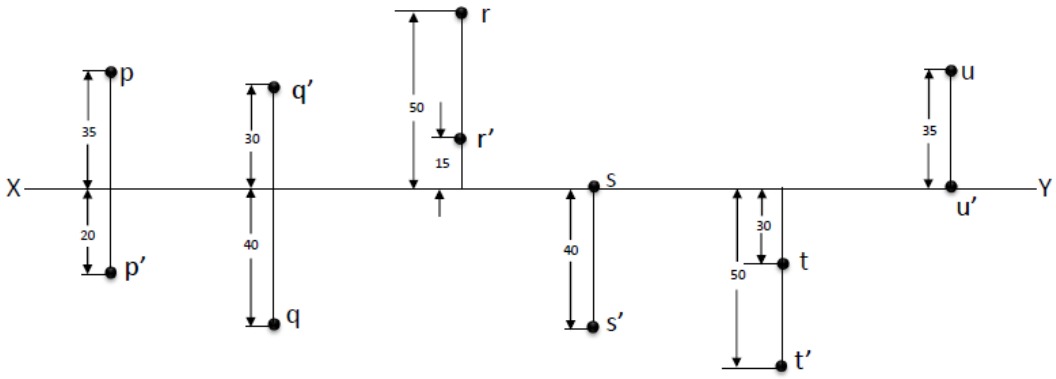
Problem.9. Point J lies on both H.P and V.P. Draw its projections.

Construction:

1. Draw a reference line **XY.**
2. Mark front view **j'** on top view **j** coinciding on the **XY.** Line

Q10.Mark the projections of the following points on a common reference line:

a) P, 35mm behind the V.P. and 20mm below the H.P.
b) Q, 40mm in front of the V.P. and 30mm above the H.P.
c) R, 50mm behind the V.P. and 15mm above the H.P.
d) S, 40 mm below the H.P. and in the V.P.
e) T, 30mm in front of V.P. and 50 mm below the H.P.
f) U, 35mm behind the V.P. and in the H.P.



3. STRAIGHT LINES:

3.1. INTRODUCTION

A straight line is defined as the locus of a point which moves unidirectional. The straight line can also be defined as the shortest distance between two points. The projections of straight lines can be drawn by joining the respective projections of its end points. Sake of simplicity. The word 'line' is used in text for straight lines for the actual length of the line is commonly called true length and is denoted by T.L.

3.2. ORIENTATION OF A STRAIGHT LINE

A straight line may be in one of the following positions.

1. Line parallel to both horizontal plane (H.P.) and vertical plane (V.P.).
2. Line perpendicular to H.P. (and parallel to V.P.).
3. Line perpendicular to V.P. (and parallel to H.P.).
4. Line inclined to H.P. and parallel to V.P.
5. Line inclined to V.P. and parallel to H.P.
6. Line inclined to both H.P. and V.P.

Projections of a straight line lying in the first angle shall have its front view above xy and the top view below xy.

.

3.3. LINE PARALLEL TO BOTH H.P. AND V.P.

It is the basic position of any line. Both the front and top views will be of true lengths

Problem.1. A 50 mm long line PQ is parallel to both the H.P. and the V.P. It is 25 mm in front of the V.P. and 60 mm above the H.P. Draw its projections and determine the traces.

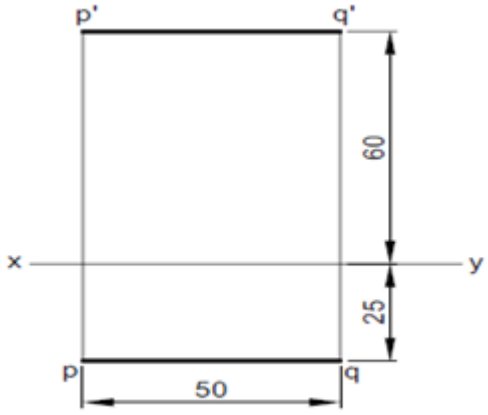


Fig. 1

Construction Refer to Fig.1.

1. Draw a reference line xy.
2. Mark point p' 60 mm above xy and point p 25 mm below xy.
3. Draw a 50 mm long line p'q' parallel to xy to represent the front view.
4. Draw another 50 mm long line pq parallel to xy to represent the top view.

3.4. LINE PERPENDICULAR TO H.P.

A line perpendicular to the H.P. is always parallel to the V.P. The front view will be of true length lying perpendicular to xy whereas the top view will be a point

Problem.2. A 60 mm long line PQ has its end P 20 mm above H.P. The line is perpendicular to the H.P. and 40 mm in front of the V.P. Draw its projections and locate the traces.

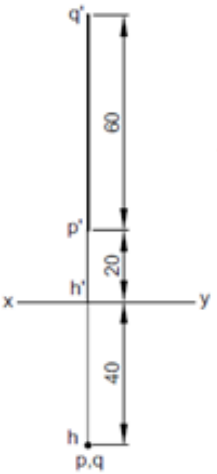


Fig.2

Construction Refer to Fig.2

1. Draw a reference line xy.
2. Mark point p' 20 mm above xy and point p 40 mm below xy.
3. Draw a 60 mm long line p'q' perpendicular to xy to represent the front view.
4. Mark point q to coincide point p. The point represents the top view of the line.

3.5. LINE PERPENDICULAR TO V.P.

A line perpendicular to the V.P. is always parallel to the H.P. The top view will be of true length lying perpendicular to xy whereas the front view will be a point.

Problem 3. A 60 mm long line PQ has its end P 20 mm in front of the V.P. The line is perpendicular to the V.P. and 40 mm above the H.P. Draw the projections of the line and determine its traces.

Construction Refer to Fig.3

1. Draw a reference line xy.
2. Mark point p' 40 mm above xy and point p 20 mm below xy.
3. Mark point q' to coincide point p'. The point represents the front view of the line.
4. Draw a 60 mm long line pq perpendicular to xy to represent the top view.

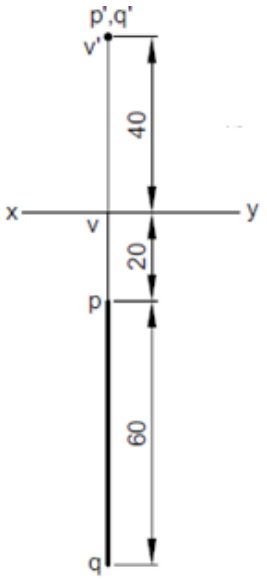


Fig.3

3.6. LINE INCLINED TO H.P. AND PARALLEL TO V.P.

When a line is inclined to the H.P. and parallel to the V.P. its front view will be of true length, inclined to xy. The top view will be of projected length (smaller than the true length) and lying parallel to xy

Problem .4. A 80 mm long line PQ has end P 20 mm above H.P. and 40 mm in front of the V.P. The line is inclined at 30° to the H.P. and is parallel to the V.P. Draw the projections of the line and determine its traces.

Construction Refer to Fig. 4

1. Draw a reference line xy.
2. Mark point p' 20 mm above xy and point p 40 mm below xy.
3. Draw an 80 mm long line p' q' inclined at 30° to xy to represent the front view.
4. Project point q' on xy to meet the horizontal line from point p at point q. Join pq to represent the top view

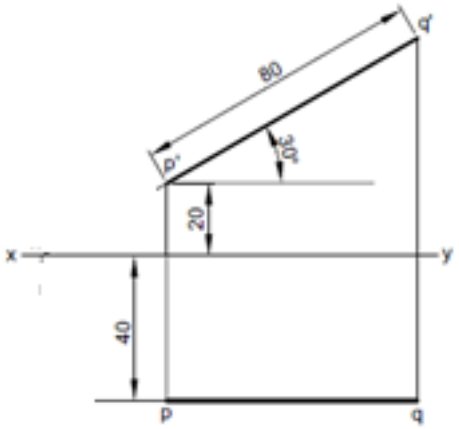


Fig. 4

3.7. LINE INCLINED TO V.P. AND PARALLEL TO H.P.

When a line is inclined to the V.P. and parallel to the H.P., its top view will be of true length which is inclined to xy. The front view will be of projected length (smaller than the true length of the line) parallel to xy

Problem 5. An 80 mm long line PQ is inclined at 30° to the V.P. and is parallel to the H.P. The end P of the line is 20 mm above the H.P. and 40 mm in front of the V.P. Draw the projections of the line and determine its traces.

Construction Refer to Fig.5.

1. Draw a reference line xy.
2. Mark point p¢ 20 mm above xy and point p 40 mm below xy.
3. Draw an 80 mm long line pq inclined at 30° to xy to represent the top view.
4. Project point q on xy to meet the horizontal line from point p' at point q¢. Join p' q' to represent the front view.

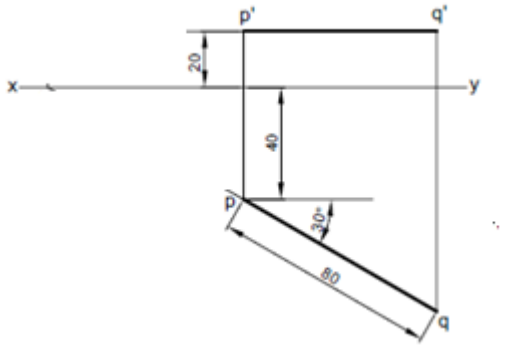
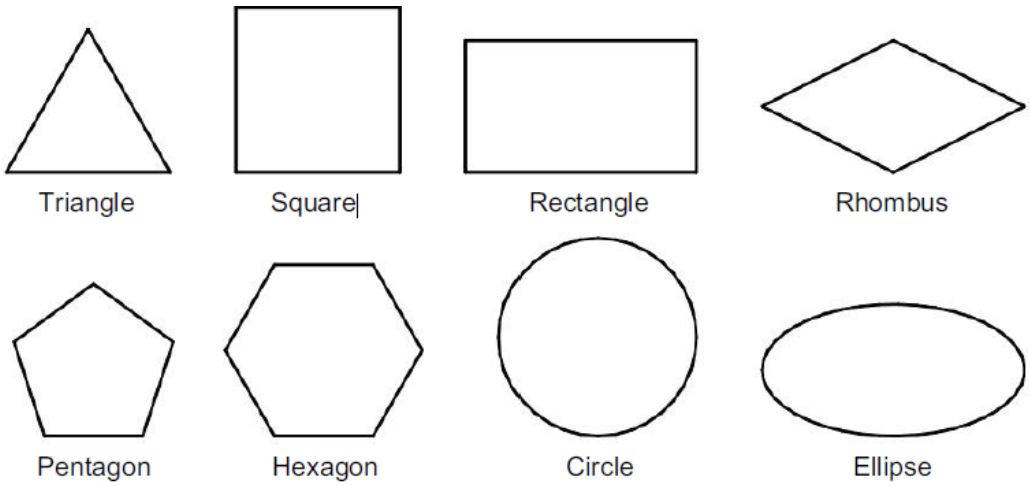


Fig.5.

4. PROJECTIONS OF PLANES

4.1. INTRODUCTION

Two-dimensional objects called planes. Planes have length, breadth and negligible thickness. Here only those planes are considered whose shape can be defined geometrically and are regular in nature. Some of these are shown in Fig.



4.2. ORIENTATION OF PLANES

The surface of a plane may be in one of the following positions

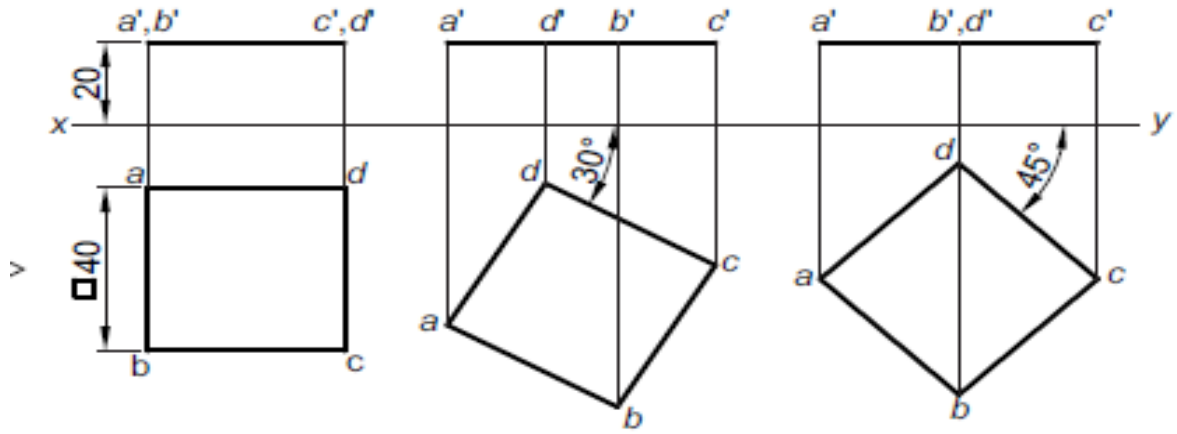
1. Parallel to H.P. (and perpendicular to V.P.).
2. Parallel to V.P. (and perpendicular to H.P.).
3. Parallel to profile plane (i.e., perpendicular to both H.P. and V.P.).
4. Inclined to H.P. and perpendicular to V.P.
5. Inclined to V.P. and perpendicular to H.P
6. Inclined to both H.P. and V.P

4.3. PLANE PARALLEL TO H.P.

- This is one of the basic positions of a plane. A plane parallel to the H.P. is always perpendicular to the V.P.
- The true shape and size of the plane can be viewed in the top view. Hence, first draw the top view and then project it to obtain a straight line representing the front view

Problem 1.

A square plane of side 40 mm has its surface parallel to and 20 mm above the H.P. Draw its projections when (a) a side is parallel to the V.P., (b) one side is inclined at 30° to the V.P. and (c) all sides are equally inclined to the V.P.



Construction:

Case (i): Draw a square abcd in the top view keeping ad parallel to ***xy***. Project the corners from the top view and mark points ***a', b', c' and d'*** 20 mm above ***xy.*** Join ***a'b'c'd'*** to represent the front view.

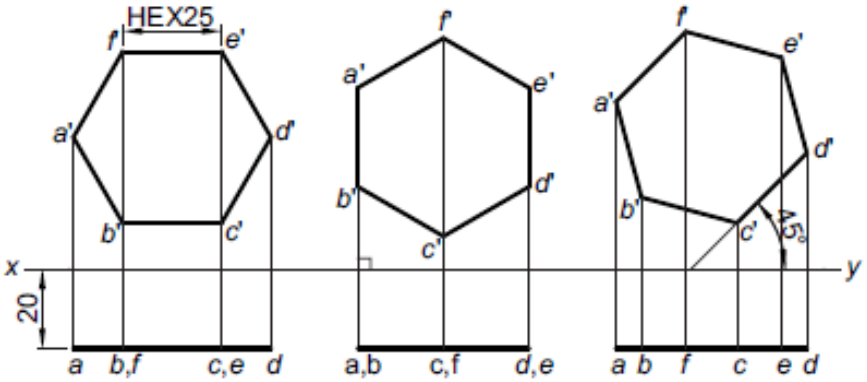
Case (ii): Draw a square abcd in the top view keeping ab inclined at ***30° to xy***. Project the corners from the top view and mark points ***a', b', c' and d'*** 20 mm above ***xy***. Join ***a'b'c'd'*** to represent the front view.

Case (iii): Draw the square abcd in the top view keeping ab inclined at ***45° to xy.*** Project the corners from the top view and mark points ***a', b', c' and d'*** 20 mm above xy. Join ***a'b'c'd'*** to represent the front view.

4.4. PLANE PARALLEL TO V.P.

This is another basic position of a plane. A plane parallel to the V.P. is always perpendicular to the H.P. The true shape and size of the plane can be viewed in the front view. Hence, first draw the front view and then project it to obtain a straight line representing the top view.

Problem 2. A hexagonal plane of side 25 mm has its surface parallel to and 20 mm in front of V.P. Draw its projections, when a side is (a) parallel to the H.P., (b) perpendicular to the H.P., (c) inclined at 45° to the H.P.



Construction:

Case (i): Draw a hexagon ***a'b'c'd'e'f'*** in the front view keeping ***b'c'*** parallel to ***xy***. Project the corners from the front view and mark points ***a, b, c, d, e and f*** 20 mm below xy. Join abcdef to represent the top view.

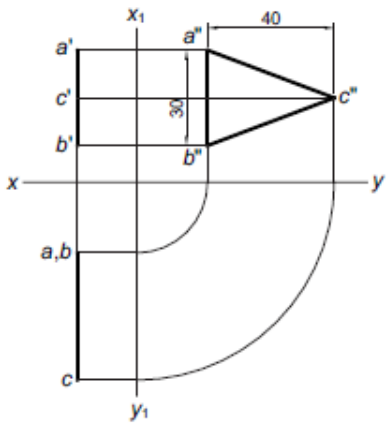
Case (ii): Draw a hexagon ***a'b'c'd'e'f*** in the front view keeping ***a'b'*** perpendicular to ***xy.*** Project the corners from the front view and mark points ***a, b, c, d, e and f*** 20 mm below xy. Join abcdef to represent the top view.

Case (iii): Draw a hexagon ***a'b'c'd'e'f*** in the front view keeping c'd' inclined at ***45° to xy.*** Project the corners from the front view and mark points ***a, b, c, d, e and f*** 20 mm below xy. Join abcdef to represent the top view

4.5.PLANE PARALLEL TO PROFILE PLANE

A plane parallel to the profile plane has its surface perpendicular to both H.P. and V.P. The true shape and size of the plane shall be viewed on the profile plane, popularly known as end view or side view. The front and top views are projected from the side view

Problem 3. A triangular plane is in the form of an isosceles triangle of base side 30 mm and altitude 40 mm. Its surface is perpendicular to both H.P. and V.P. Draw its projections when the base side is parallel to the V.P.



Construction:

1. Draw a triangle ***a''b''c''*** as the side view keeping ***a''b''*** perpendicular to xy.
2. Project the corners on ***x1y1*** and obtain points ***a', b' and c'*** at some distance from ***x1y1.*** Join ***a'b'c'*** to represent the front view.
3. Project ***a', b' and c'*** on xy and extend them to meet projectors coming from the side view to intersect at points ***a, b and c.*** Join a b c to represent the top view.

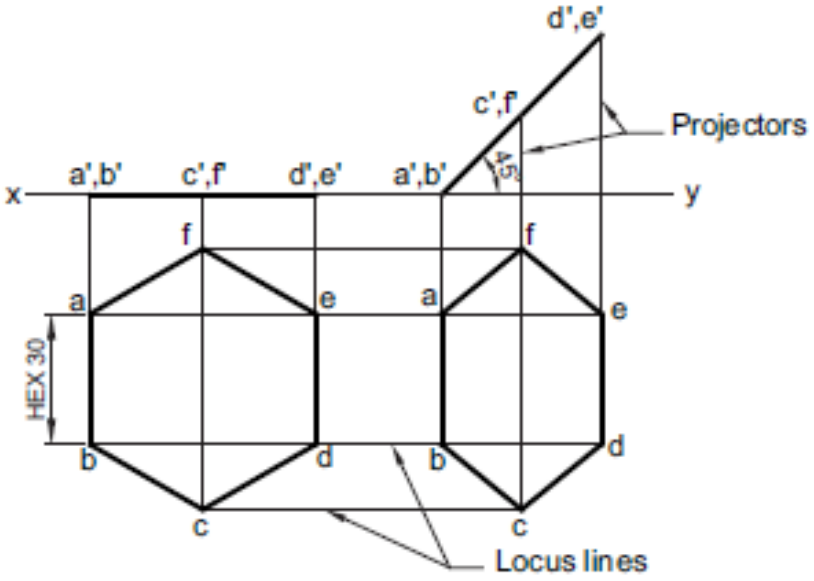
4.6. LANE INCLINED TO H.P. AND PERPENDICULAR TO V.P.

When the surface of the plane is inclined at θ to the H.P. and perpendicular to the V.P. the projections are obtained in two stages. In the first stage, the plane is assumed to lie on the H.P. The true shape of the plane is viewed in the top view and a straight line lying on XY in the front view. In the second stage, the plane is tilted at θ to the H.P. The front view is redrawn inclined at θ to the XY. The final top view is obtained by joining the points of intersection of the vertical projectors of the corners from the front view with the horizontal projectors of the corners from the top view of the preceding stage.

Note 1: If the plane has a side on the H.P. (or parallel to the H.P. or on the ground), then keep an edge of the plane perpendicular to xy in the top view of the first stage.

Note 2: If the plane has a corner in the H.P. (or on the ground), then keep the line joining a corner and the center of the plane parallel to xy.

Problem 4. A hexagonal plane of side 30 mm has an edge on the H.P. The surface is inclined at 45° to the H.P. and perpendicular to the V.P. Draw its projections.



Construction

The plane has an edge on the H.P., so consider that initially the hexagonal plane is placed on the H.P. With side ***AB*** perpendicular to the V.P.

1. First stage: Draw a hexagon abcdef keeping ab perpendicular ***to xy*** to represent the top view. Project the corners to xy and obtain ***(a') b (c')' f' (e') d'*** as the front view.

2. Second stage: Reproduce the front view of the first stage, keeping line ***(a') b (c')' f' (e') d'*** inclined at ***45° to xy***. Obtain new points a***, b, c, d, e and f*** in the top view by joining the points of intersection of the projectors drawn from the front view of the second stage with the corresponding horizontal locus lines drawn from the top view of the first stage. Join new abcdef to represent the final top view.

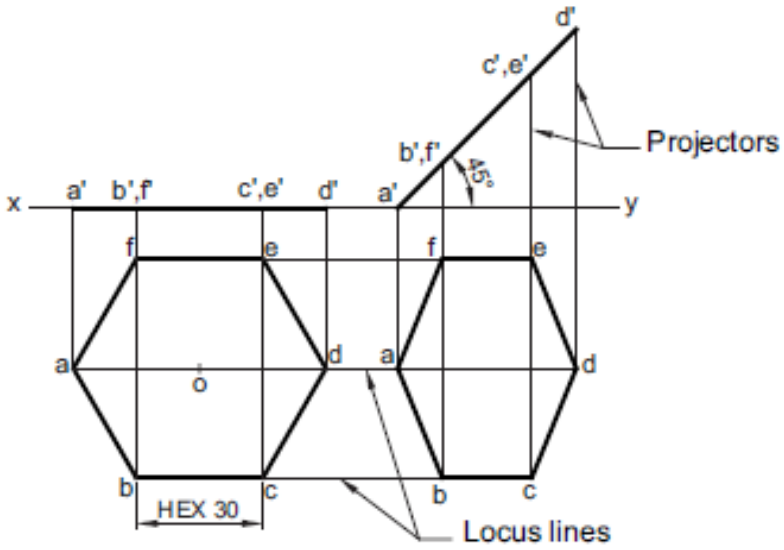
Problem 5. A hexagonal plane of side 30 mm has a corner on the ground. Its surface is inclined at 45° to the H.P. and perpendicular to the V.P. Draw its projections when the diagonal through the corner in the H.P. is parallel to the V.P.

Construction

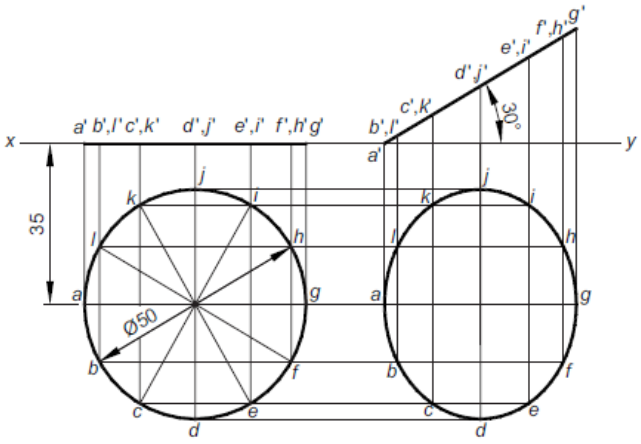
The plane has a corner on the H.P., so consider that the plane ***ABCDEF*** is placed on the H.P. with line joining the corner A and the center of the plane parallel to the V.P.

1. First stage: Draw a hexagon ***abcdef*** keeping ao parallel to xy to represent the top view. Project the corners to xy and obtain ***a' b (f')' c' (e') d'*** as the front view.

2. Second stage: Reproduce the front view of first stage, keeping a¢ on xy and ***a' b (f')' c' (e') d'*** inclined at 45° to xy. Obtain new points a, b, c, d, e and f in the top view by joining the points of intersection of the projectors drawn from the front view of the second stage with the corresponding horizontal locus lines drawn from the top view of the first stage. Join new abcdef to represent the final top view.



Problem 6. A circular plane of diameter 50 mm is resting on a point of the circumference on the H.P. The plane is inclined at 30° to the H.P. and its center is 35 mm in front of the V.P. Draw its projections.



Construction

A circle has a point of the circumference on the H.P. so consider that initially the circle is placed on the H.P.

1. **First stage:** Draw a circle of diameter 50 mm keeping Centre 35 mm below xy to represent the top view. Divide the circle in 12 equal parts and project all the points to xy and obtain ***a' b' (l') c' (k') d' (j') e' (i') f' (h') g'*** as the front view.

2. **Second stage:** Reproduce the front view of first stage keeping ***a' on*** xy and ***a' b' (l') c' (k') d' (j') e' (i') f' (h') g'*** inclined at 30° to the xy. Obtain points **a, b, c, etc.,** in the new top view by joining the point of intersection of the vertical projectors drawn from front view of the second stage with the corresponding horizontal locus lines drawn from the top view of the first stage. Join new ***abcdefghijkl*** to represent the final top view

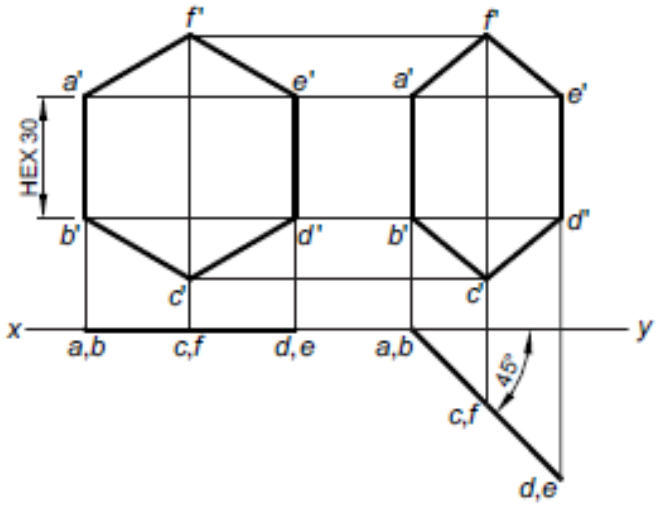
4.7. PLANE INCLINED TO V.P. AND PERPENDICULAR TO H.P.

When the surface of the plane is inclined at f to the V.P. and perpendicular to the H.P., the projections are drawn in two stages. In the first stage, the plane is assumed to lie in the V.P. The true shape of the plane is viewed in the front view and a straight line lying on xy in the top view. In the second stage, the plane is tilted at f to the V.P. The top view is redrawn inclined at f to the xy. The final front view is obtained by joining the points of intersection of the vertical projectors of the corners from the top view with the horizontal projectors of the corners from the front view of the preceding stage.

Note 1: If the plane has a side parallel to the V.P. or in the V.P., then keep an edge of the plane perpendicular to xy in the front view of the first stage.

Note 2: If the plane has a corner in the V.P., then keep the line joining a corner and the center of the plane parallel to xy in the front view of the first stage.

Problem 7. A hexagonal plane of side 30 mm has an edge in the V.P. The surface of the plane is inclined at 45° to the V.P. and perpendicular to the H.P. Draw its projections.



Construction

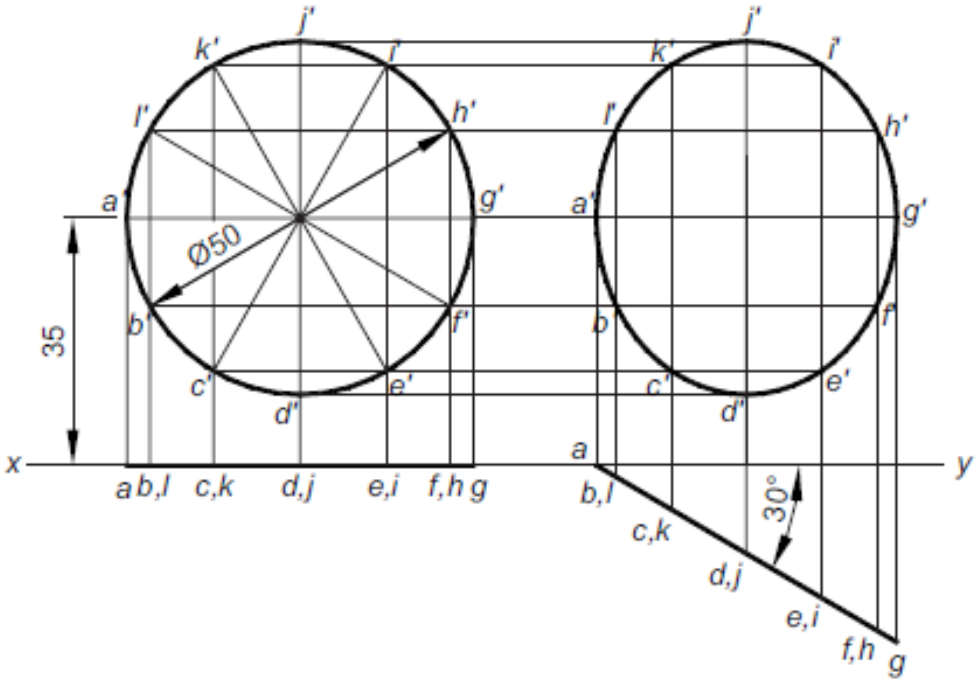
The plane has an edge in the V.P., so consider that initially the hexagonal plane ***ABCDEF*** is placed in the V.P. with side AB perpendicular to the H.P.

1. **First stage:** Draw a hexagon ***a', b', c', d', e', f'*** keeping ***a'b'*** perpendicular to ***xy*** to represent the front view. Project the corners to ***xy*** and obtain ***b d*** as the top view.
2. **Second stage:** Reproduce the top view of first stage keeping ab on ***xy*** and bd inclined at 45° to ***xy***. Obtain new points ***a', b', c', d', e' and f'*** in the front view by joining the points of intersection of the projectors drawn from top view of the second stage with the corresponding horizontal locus lines drawn from the front view of the first stage. Join new ***a'b'c'd'e'f'*** to represent the final front view.

Problem 8. A circular plane of diameter 50 mm is resting on a point of the circumference on the V.P. The plane is inclined at 30° to the V.P. and the center is 35 mm above the H.P. Draw its projections.

Construction

A circle has a point of the circumference on the V.P. so consider that initially the circle is placed in the V.P.

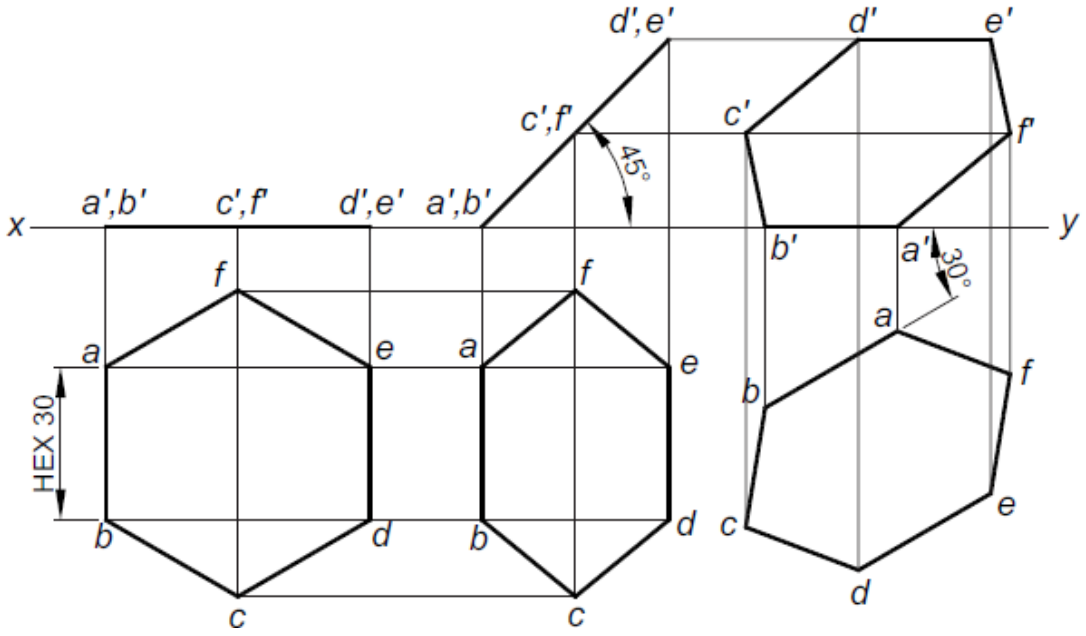


1. **First stage**: Draw a circle of diameter 50 mm keeping center 35 mm above ***xy*** to represent the front view. Divide the circle in 12 equal parts. Project all the points to ***xy*** and obtain ***ag*** as the top view.
2. **Second stage:** Reproduce the top view of first stage keeping ***a*** on ***xy*** and ***ag*** inclined at ***30° to xy***. Obtain points ***a', b', c', d', etc.,*** in the new front view by joining the point of intersection of the vertical projectors drawn from the top view of the second stage with the corresponding horizontal

4.8. PLANE INCLINED TO BOTH THE REFERENCE PLANES

When the surface of a plane is inclined to both the reference planes, its projections are drawn in three stages. It is the extension of the problems done earlier on projections of planes inclined to one of the reference planes. An Element of the Plane in H.P.

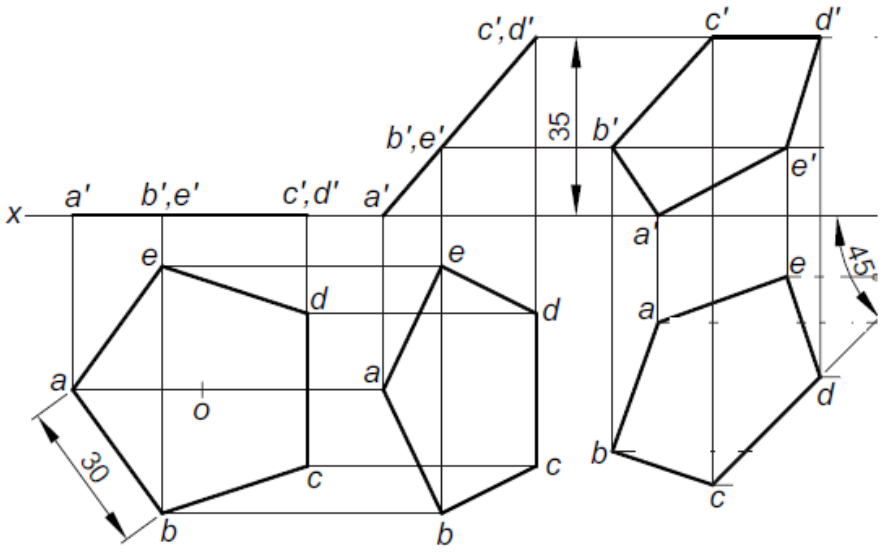
Problem 9. A hexagonal plane of side 30 mm has an edge on the H.P. Its surface is inclined at 45° to the H.P. and the edge on which the plane rests is inclined at 30° to the V.P. Draw its projections.



Construction

1. **First stage:** Draw a hexagon abcdef keeping ***ab*** perpendicular to ***xy*** to represent the top view. Project the corners to ***xy*** and obtain ***b'd'*** as the front view.
2. **Second stage:** Reproduce the front view of first stage keeping ***a'b'*** on ***xy*** and ***b'd'*** inclined at ***45° to xy***. Obtain points ***a, b, c, d, e and*** f of the top view by joining the points of intersection of the projectors from points ***a', b' c', d', e' and f'*** of the second stage with the corresponding locus lines from points ***a, b, c, d, e and f*** of the first stage. Join ***abcdef.***
3. **Third stage:** Reproduce the top view of the second stage keeping line ***ab*** inclined at ***30° to xy***. Obtain point ***a', b', c', d', e' and f'*** of the front view by joining the points of intersection of the projectors from points ***a, b, c, d, e and f*** of the third stage with the corresponding locus lines from points ***a', b', c', d', e' and f'*** of the second stage. Join ***a'b'c'd'e'f'.***

Problem 10. A pentagonal plane of side 30 mm is resting on a corner in the H.P. The side opposite to the corner in the H.P. is parallel to and 35 mm above H.P. and inclined at 45° to the V.P. Draw its projections



Construction

1. **First stage:** Draw a pentagon abcde keeping ao parallel to ***xy*** to represent the top view. Project the corners to ***xy*** and obtain ***a'c'*** as the front view.
2. **Second stage:** Redraw the front view of first stage keeping ***a'*** on ***xy*** and ***c'd' 35 mm*** above ***xy.*** Obtain points ***a, b, c, d and e*** of the top view by joining the points of intersection of the projectors from points ***a', b', c', d' and e'*** of the second stage with the corresponding locus lines from points ***a, b, c, d and e*** of the first stage. Join abcde.
3. **Third stage:** Reproduce the top view of the second stage keeping ***cd*** inclined at ***45° to xy***. Obtain point ***a', b', c', d' and e'*** of the front view by joining the points of intersection of the projectors from points ***a, b, c, d and e*** of the third stage with the corresponding locus lines from points ***a', b', c', d' and e'*** of the second stage. Join ***a'b'c'd'e'.***

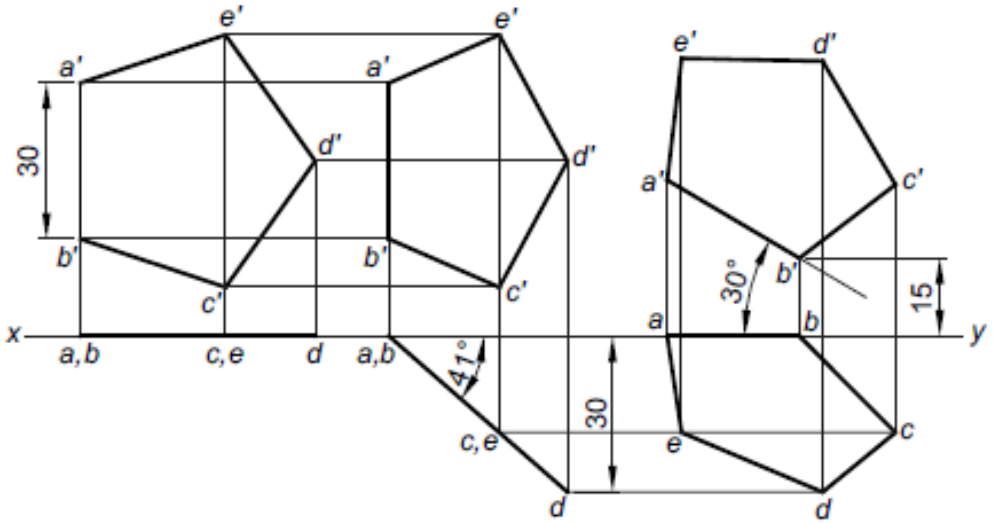
Problem 18. A pentagon ABCDE of side 30 mm has its side AB in the V.P. and inclined at 30° to the H.P. and the corner B is 15 mm above the H.P. and the corner D is 30 mm in front of the V.P. Draw the projections of the plane and find its inclination with the V.P.

Construction

1. **First stage:** Draw a pentagon ***a'b'c'd'e'*** keeping side ***a' b'*** perpendicular to ***xy*** to represent the front view. Project all the corners to xy and obtain ***ad*** as the top view.
2. **Second stage:** Reproduce the top view of first stage keeping ***ab*** on ***xy*** and ***d 30 mm below xy.*** Measure inclination of ***ad*** with xy as inclination of plane with V.P. ***Here f = 41°.*** Obtain

points ***a', b', c', d' and e'*** of the front view by joining the points of intersection of the projectors from points ***a, b, c, d and e*** of the second stage with the locus lines from points ***a', b', c', d' and e'*** of the first stage. Join ***a'b'c'd'e'.***

3. **Third stage:** Reproduce the front view of the second stage keeping ***b' is 15 mm above xy*** and ***a'b'*** is inclined at ***30° to xy.*** Obtain points ***a, b, c, d and e*** for the top view by joining the points of intersection of projectors from points ***a, b', c', d' and e'*** of the third stage with the locus lines from points ***a, b, c, d and e*** of the second stage. Join ***abcde.***

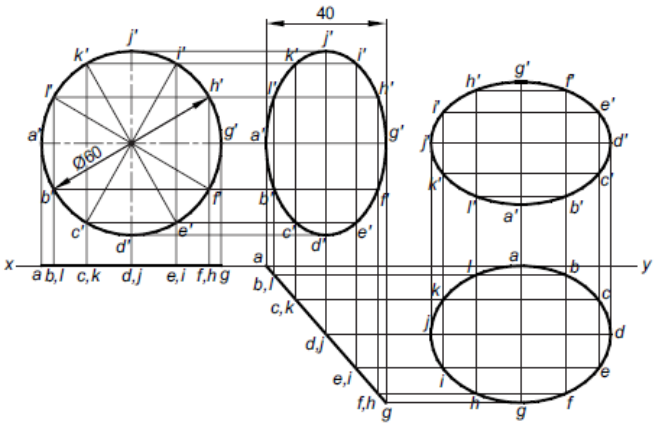


Problem 11. A thin circular plate of diameter 60 mm appears in the front view as an ellipse of major and minor axes 60 mm and 40 mm respectively. Draw its projections when one of the diameters is parallel to both the reference planes.

Construction

1. **First stage**: Draw a circle ***a'd'g'j'*** to represent the front view. Divide it into ***12 equal parts.*** Project all the points to xy and obtain ***ag*** as the top view.
2. **Second stage:** Draw locus line from points ***a' and g'*** of the first stage. Mark on it points ***a' and g'*** such that they ***are 40 mm apart*** (equal to the length of the minor axis). Project ***a' to meet xy at point a***. Draw an arc with center ***a*** and radius equal to length ag of the first stage to meet the projector of point ***g' at g***. Join ***ag***. Mark other points on line ***ag*** so that it becomes the copy of ***ag*** of the first stage. Obtain points ***a', b', c', d', etc.,*** of the front view by joining the points of intersection of the projectors from points ***a, b, c, d, etc.,*** of the second stage with the locus lines from ***points a', b', c', d', etc.,*** of the first stage. Join ***a'b'c'd'e'f'g'h'i'j'k'l'***.
3. **Third stage:** Reproduce the front view of the second stage keeping ***dj*** parallel to ***xy***. Obtain points ***a, b, c, d, etc.,*** for the top view by joining the points of intersection of the projectors

from points ***a', b', c', d' etc.***, of the third stage with the locus lines from points ***a, b, c, d, etc.,*** of the second stage. Join ***abcdefghijkl.***



5. PROJECTIONS OF SOLIDS

5.1. INTRODUCTION

This chapter deals with the orthographic projections of three-dimensional objects called solids. However, only those solids are considered the shape of which can be defined geometrically and are regular in nature. The basic concepts of orthographic projections discussed in earlier chapters shall also apply here.

5.2. CLASSIFICATION OF SOLIDS

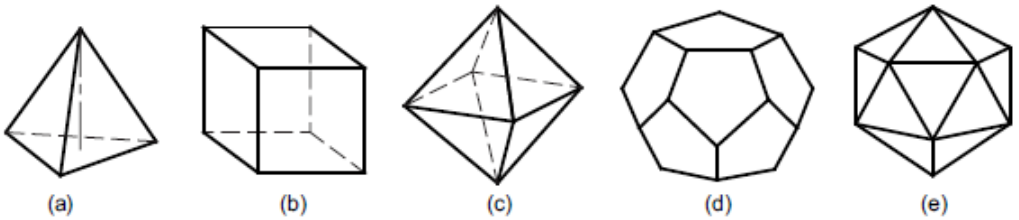
Solids are usually classified as given below:

1. Polyhedron
2. Solid of revolution.

5.3. Polyhedron

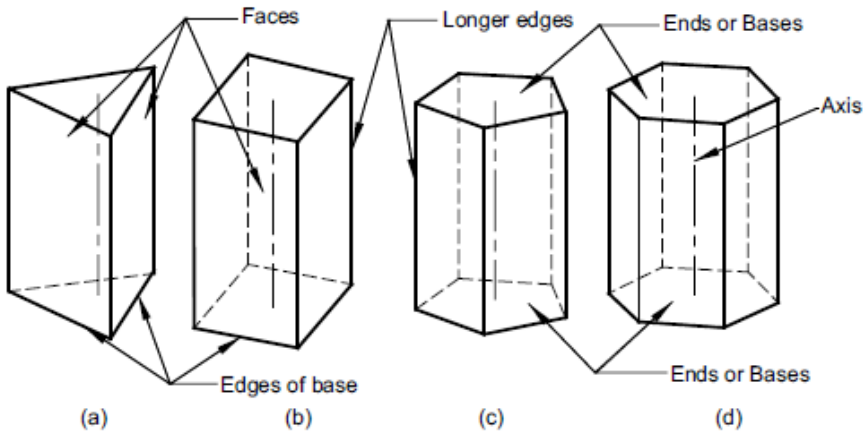
A polyhedron is a solid bounded by planes called faces, which meet in straight lines called edges. A regular polyhedron has all the faces equal and regular are usually classified as given below

1. **Tetrahedron:** It has four equal equilateral triangular faces.
2. **Cube:** It has six equal square faces.
3. **Octahedron:** It has eight equal equilateral triangular faces.
4. **Dodecahedron**: It has 12 equal pentagonal faces.
5. **Icosahedron:** It has 20 equal equilateral triangular faces



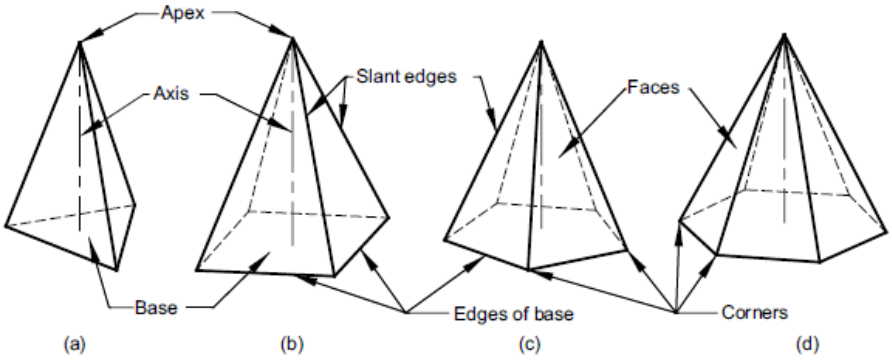
Regular polyhedron **(a)** *Tetrahedron* **(b)** *Cube* **(c)** *Octahedron* **(d)** *Dodecahedron* **(e)** *Icosahedron*

6. **Prism:** A prism is a polyhedron with two n-sided polygonal bases which are parallel and corresponding, and lateral faces are rectangles. All cross-sections parallel to the bases are similar with the bases. An imaginary line that joins the center of the bases is called an axis. A right and regular prism has regular polygonal bases, axis perpendicular to the bases and all the faces are equal rectangles, as shown in Fig. Prisms are named according to the shape of their base, so a prism with a triangular base is called a triangular prism; a square base is called a square prism and so on.



Prisms **(a)** *Triangular* **(b)** *Square* **(c)** *Pentagonal* **(d)** *Hexagonal*

7. **Pyramid:** A pyramid is a polyhedron with n-sided polygonal base and lateral faces are triangles meeting at a point called the vertex or apex. An imaginary line that joins the apex with the center of the base is known as the axis. A right and regular pyramid has a regular polygon base, axis perpendicular to the base and all the faces are equal isosceles triangles, as shown in Fig. 11.4. Pyramids are named according to the shape of their base, so a pyramid with a triangular base is called a triangular pyramid; a square base is called a square pyramid and so on. The center of gravity of pyramids lies on the axis at one-fourth of its height from the base

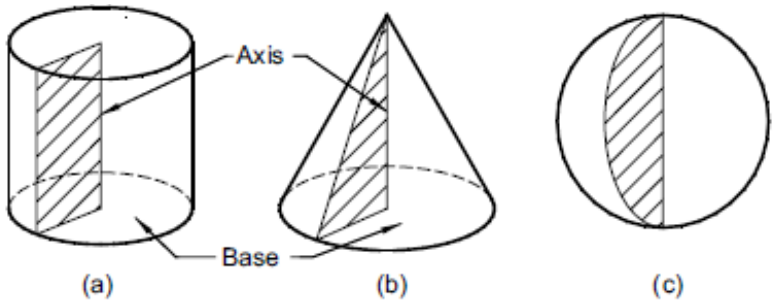


Pyramids **(a)** *Triangular* **(b)** *Square* **(c)** *Pentagonal* **(d)** *Hexagonal*

5.4. Solid of Revolution

These solids are obtained by revolving a plane figure like rectangle, triangle or a semi-circle about a fixed line.

1. **Cylinder** A cylinder is a solid of revolution obtained by revolving a rectangle about one of its fixed side called an axis. It can be imagined as a prism of infinite number of lateral faces. Any line on the surface of a cylinder is called its generator. Thus, a cylinder has an infinite number of generators. A right cylinder has all the generators and the axis perpendicular to the base, as shown in Fig.(a).
2. **Cone** A cone is obtained by revolving a triangle about its fixed side called an axis. A cone can be imagined as a pyramid with infinite number of lateral faces. Any line on the surface of a cone is called its generator. Thus, a cone has an infinite number of generators. A right cone has all generators of equal length and the axis perpendicular to the base, as shown in Fig. (b).
3. **Sphere** A sphere is obtained by revolving a semi-circle around its diameter, as shown in Fig. (c).



Solids of revolution **(a)** *Cylinder* **(b)** *Cone* **(c)** *Sphere*

5.5. ORIENTATION OF SOLID

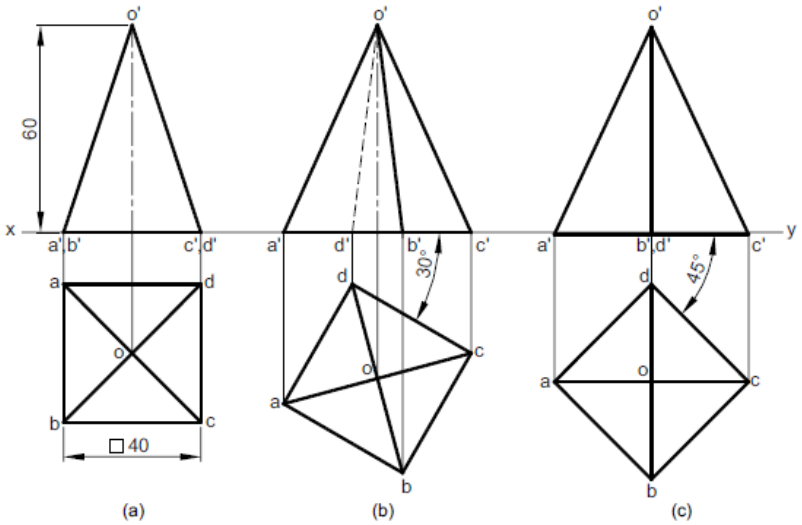
The solid may be in one of the following positions:

1. Axis perpendicular to the H.P.
2. Axis perpendicular to the V.P.
3. Axis parallel to both the H.P. and the V.P. (i.e., perpendicular to the profile plane)
4. Axis inclined to the H.P. and parallel to the V.P.
5. Axis inclined to the V.P. and parallel to the H.P.
6. Axis inclined to both the H.P. and the V.P.

5.6 AXIS PERPENDICULAR TO H.P.

This is one of the basic positions of the solid. It is evident that if the axis of a right solid is perpendicular to the H.P., its base will be parallel to the H.P. The true shape and size of the base can be viewed in the top view. Therefore, first obtain the top view of the solid and then project it to obtain the front view

Problem.1. A square pyramid of base side 40 mm and axis 60 mm is resting on its base on the H.P. Draw its projections when (a) a side of the base is parallel to the V.P., (b) a side of the base is inclined at 30° to the V.P., (c) all the sides of the base are equally inclined to the V.P.



Construction

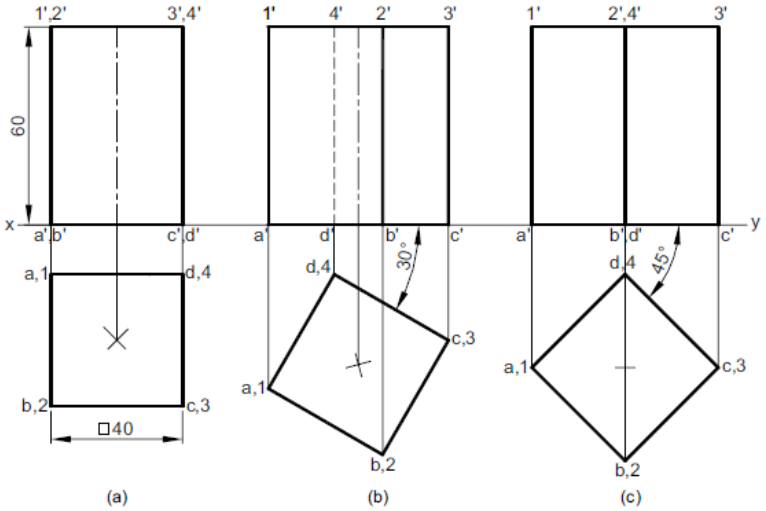
1. Side of the base parallel to V.P. (Fig.(a)) Draw a square abcd keeping ad parallel to the ***xy.*** Locate center o and join it with all the corners ***a, b, c and d.*** This represents the top view. Project points ***a, b, c and d on xy*** and obtain points ***a', b', c' and d'.*** Project point ***o, 60 mm above xy*** and mark it as ***o'. Join o'a'b' and o'c'd'***. This is the required front view.
2. A side of the base inclined at ***30° to V.P.*** (Fig.(b))Draw a square abcd keeping dc inclined ***at 30° to the xy***. Locate center o and join it with the corners ***a, b, c and d***. This represents the top view. Project ***a, b, c and d on xy to obtain a', b', c' and d'.*** Project point ***o, 60 mm above xy*** and mark it ***as o'. Join a'o', b'o', c'o' and d'o'.*** This is the required front view. It may be noted that d'o' is not visible and should be shown using dashed narrow line.
3. All the sides of the base equally inclined to ***V.P.*** (Fig.(c)) Draw a square abcd keeping sides inclined ***at 45° to the xy.*** Locate center o and join it with the ***corners a, b, c and d.*** This represents the top view. Project points ***a, b, c and d on xy*** and obtain points ***a', b', c' and d'.*** Project point ***o, 60 mm above the xy*** and mark it as ***o'. Join a'o', b'd'o' and c'o'.*** This is the required front view.

Problem 2. A square prism of base side 40 mm and axis 60 mm is resting on its base on the ground. Draw its projections when (a) a face is perpendicular to the V.P., (b) a face is inclined at 30° to the V.P., (c) all the faces are equally inclined to the V.P.

Construction

1. Face perpendicular to the V.P. (Fig.(a)) Draw a square ***abcd*** keeping ab perpendicular to ***xy***. This represents the top view. Project all the corners of the top view on ***xy*** and obtain points ***a', b', c' and d'.*** Mark points ***1', 2', 3' and 4', 60 mm above xy.*** Join all the edges and obtain the required front view.

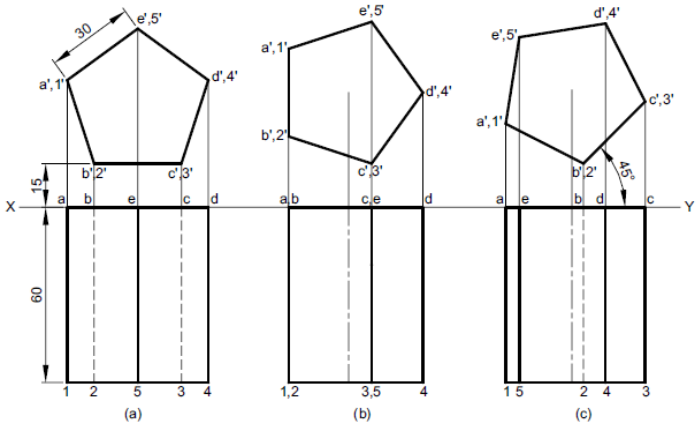
2. Face inclined ***at 30° to the V.P***. (Fig.(b)) Draw a square ***abcd*** keeping cd inclined at ***30° to xy***. This represents the top view. Project all the corners of the top view on xy and obtain points ***a', b', c' and d'.*** Mark ***points 1', 2', 3' and 4', 60 mm above xy***. Join all the edges and obtain the required front view. Edge D, 4 is not visible in the front view so d', 4' should be shown using dashed narrow line.
3. All the faces equally inclined to the V.P. (Fig. (c)) Draw a square ***abcd*** keeping sides inclined at ***45° to xy.*** This represents the top view. Project all the corners of the top view on ***xy*** and obtain ***a', b', c' and d'.*** Mark points ***1', 2', 3' and 4', 60 mm above xy.*** Join all the edges and obtain the required front view



5.7. AXIS PERPENDICULAR TO V.P.

This is another basic position of the solid. It is evident that if the axis of a right solid is perpendicular to V.P., its base will be parallel to the V.P. The true shape and size of the base can be viewed in the front view. Therefore, first obtain the front view of the solid and then project it to obtain the top view

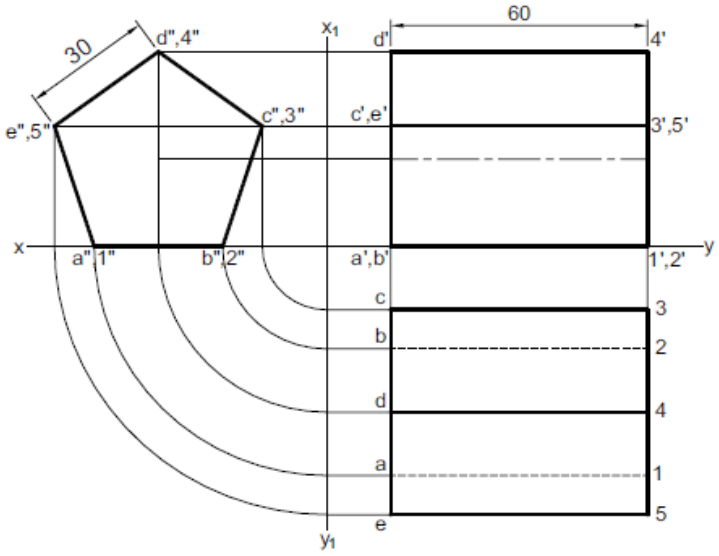
Problem 3. A pentagonal prism of base side 30 mm and axis 60 mm has one of its bases in the V.P. Draw its projections when (a) a rectangular face is parallel to and 15 mm above the H.P., (b) a face is perpendicular to the H.P., (c) a face is inclined at 45° to the H.P.



5.8. AXIS PARALLEL TO BOTH H.P. AND V.P.

It is evident that if the axis of right solids is parallel to both H.P. and V.P., the base of the solid will be perpendicular to the reference planes and parallel to the profile plane. The true shape and size of the base can be viewed in the side view. Therefore, first obtain the side view of the solid and then project it to obtain the front and the top views.

Problem 4. A pentagonal prism of base side 30 mm and axis 60 mm is resting on one of its rectangular faces on the H.P. with axis parallel to the V.P. Draw its projections



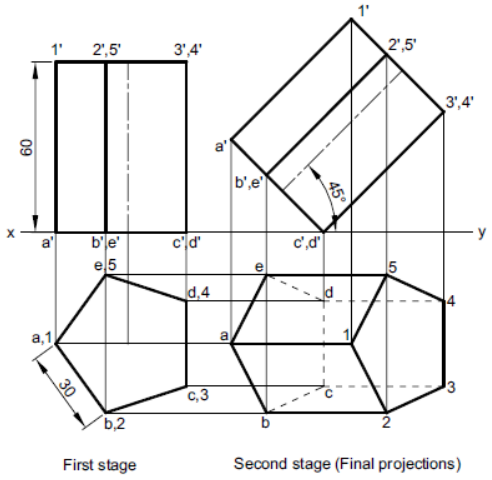
Construction

1. As the axis is parallel to both the planes, the true shape and size of the base is seen in the side view. Therefore, draw a pentagon ***a''b''c''d''e'' keeping a''b'' on xy.***
2. Project the corners from the side view ***on x1y1*** and produce to obtain the front view **a'1'4'd'**.
3. Project the corners from the side view on ***xy,*** rotate it through ***90°*** and then extend the***a'1'4'd'***m parallel to xy. Project the front view to meet them and ***obtain e53c*** as the required top view. ***Edges a1 and b2*** are not visible and should be drawn using dashed narrow lines.

5.9. AXIS INCLINED TO H.P. AND PARALLEL TO V.P.

When the axis of a right solid is inclined to the H.P. and parallel to the V.P., then the projections are drawn in two stages. Consider the following problems.

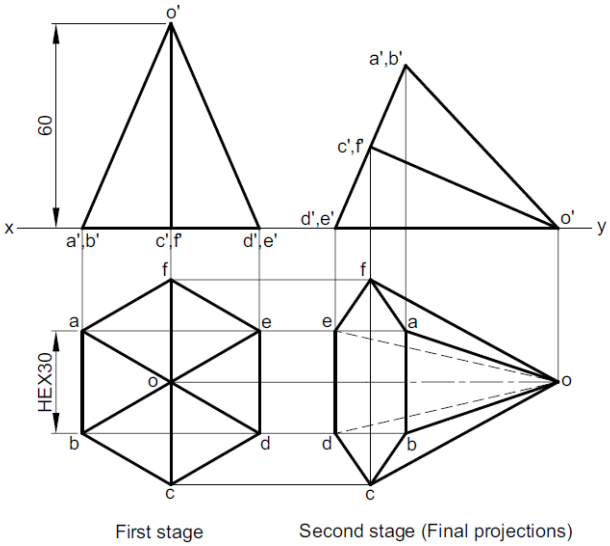
Problem 5. A pentagonal prism of base edge 30 mm and axis 60 mm rests on an edge of its base in the H.P. Its axis is parallel to V.P. and inclined at 45° to the H.P. Draw its projections.



Construction:

1. **First stage**: Draw a pentagon ***abcde*** keeping side ***cd*** perpendicular ***to xy.*** This represents the top view. Project all the corners and obtain ***a'd'4'1'*** to represent the front view.
2. **Second stage:** Reproduce the front view of the first stage keeping ***c'd' on xy and c'3'inclined at 45°*** to it. Obtain ***a, b, c, d, e, 1, 2, 3, 4 and 5*** in the top view as the intersecting points of the projectors from the front view of the second stage with the corresponding locus lines from the top view of the first stage.
3. Join the outlines ***ab, b2, 2-3, 3-4, 4-5, 5e and ae*** using continuous lines. The ***corner 1'*** is towards the observer, therefore ***join 1a, 1-2 and 1-5*** using continuous lines. The ***edge c'd' is on xy***, therefore join ***cd, cb, c3, de and d4*** using dashed narrow lines

Problem 6. A hexagonal pyramid of base edge 30 mm and axis 60 mm, has a triangular face on the ground and the axis parallel to the V.P. Draw its projections.



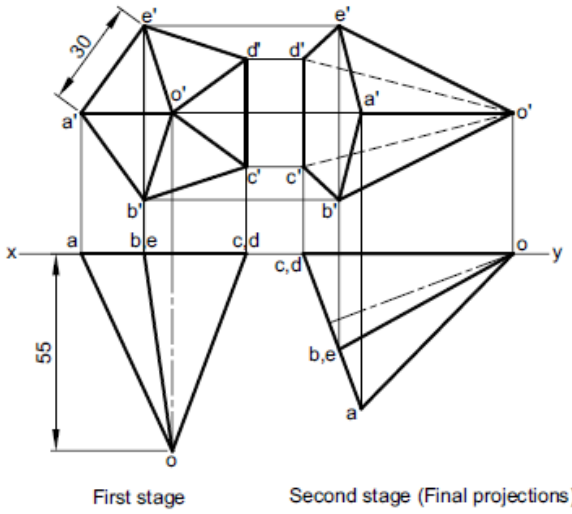
Construction Refer to Fig.

1. **First stage**: Draw a hexagon ***abcdef*** keeping side de perpendicular to ***xy***. Join the corners of the hexagon with the centroid o. This represents the top view. Project all the corners and obtain ***b'd'o'*** to represent the front view.
2. **Second stage:** Reproduce the front view of the first stage keeping line ***e'd'o' on xy.*** Obtain ***a, b, c, d, e, f and o*** in the top view as the intersecting points of the projectors from the front view of the second stage with the corresponding locus lines from the top view of the first stage.
3. The face ***o'd'e' is on xy*** (away from observer), therefore join ***od and oe*** using dashed narrow lines. Join the remaining edges using continuous lines.

5.10. AXIS INCLINED TO V.P. AND PARALLEL TO H.P.

When the axis of a right solid is inclined (at ϕ) to the V.P. and parallel to the H.P., then the projections are drawn in two stages. Consider the following problems.

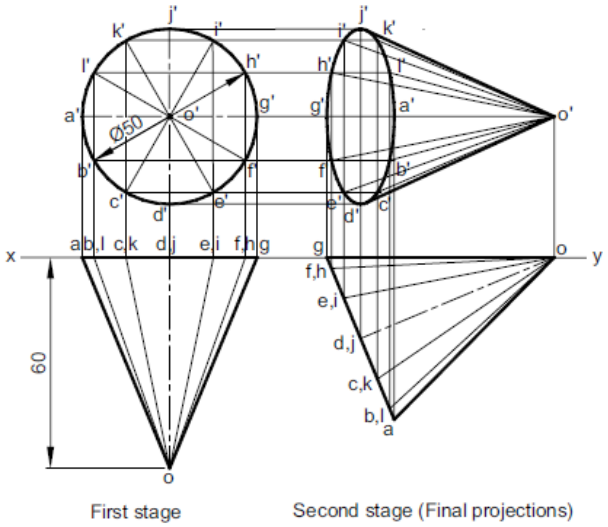
Problem 7. A pentagonal pyramid of base side 30 mm and axis 55 mm has a triangular face in the V.P. and the base edge contained by that triangular face is perpendicular to the H.P. Draw its projections.



Construction Refer to Fig.

1. **First stage:** Draw a pentagon ***a'b'c'd'e'*** keeping ***c'd'*** perpendicular to ***xy***. Join the corners of the pentagon with the centroid ***o'.*** This represents the front view. Project all the corners and obtain ***ado*** to represent the top view.
2. **Second stage:** Reproduce the top view of the first stage keeping ***cdo on xy***. Obtain a***', b', c', d', e¢ and o'*** in the front view as the intersecting points of the projectors from the top view of the second stage with the corresponding locus lines from the front view of the first stage.
3. Join the outlines ***b'c', c'd', d'e', e'o' and o'b'*** using continuous lines. The corner a is towards the observer, therefore join ***a'b', a'e' and a'o'*** using continuous lines. The face ***cdo is on xy***, therefore join ***c'o' and d'o'*** using dashed narrow lines.

Problem 8. A cone of base diameter 50 mm and axis 60 mm has a generator in the V.P. and the axis parallel to the H.P. Draw its projections.



Construction Refer to Fig.

1. **First stage**: Draw a circle ***adgj*** and divide into ***12 equal parts*** to represent the front view. Project the front view and obtain ***aog*** to represent the top view.
2. **Second stage:** Reproduce the top view of the first stage keeping generator ***og on xy***. Obtain points ***a', b', c', d', e', f', g', h', l', j', k', l' and o'*** in the front view as the intersecting points of the projectors from the top view of the second stage with the corresponding locus lines from the front view of the first stage. Join visible edges with continuous lines

6. ISOMETRIC PROJECTIONS

6.1. INTRODUCTION

Isometric projection is used to create a pictorial drawing of an object. It is defined as a single-view parallel projection obtained by keeping the object in such a position that all the three mutually perpendicular geometrical axes are equally inclined to the plane of projection. The projectors follow the rules of orthographic projections, i.e. projectors are parallel to each other and perpendicular to the plane of projection.

6.2. ISOMETRIC PROJECTION:

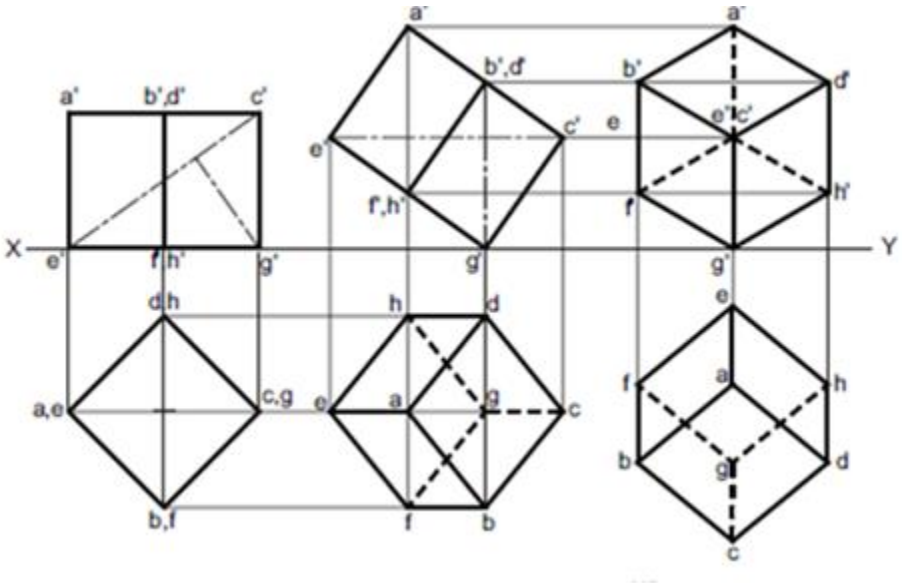
Isometric projection is an axonometric projection of an object so placed that all three axes make equal angle with the plane of projection. In other words, all the three axes and the lines parallel to them, respectively, have the same ratios of foreshortening

when projected to the plane of projection (See Fig.6.1). since the three axes are foreshortened equally, single isometric scale is prepared and used.

Fig.6.1: Isometric projection

6.3. PRINCIPLE OF ISOMETRIC PROJECTION

The term 'isometric' comes from the Greek language which means 'equal measure', reflecting that the scale along each axis of the projection is the same. The isometric projection can be visualized is by considering a view of a cube with one of the solid diagonals perpendicular to the vertical plane and the three axes equally inclined to the vertical plane as shown in Fig. 6.2. The final front view is the isometric projection of the cube.



Fog. 6.2: Cube rests on the H.P. with a solid diagonal perpendicular to the V.P.

6.4. TERMINOLOGY

Referring to Fig. the important terms used in isometric projections are as follows:

1. **Isometric axes:** The three lines CB, CD and CG, meeting at point C and inclined at an angle of 120° with each other, are called isometric axes.

2. **Isometric lines:** The lines parallel to the isometric axes are called isometric lines. Here lines AB, BF, FG, GH, DH and AD are isometric lines.
3. **Non-isometric lines**: The lines which are not parallel to isometric axes are known as non-isometric lines. Here diagonals BD, AC, CF, BG, etc., are non-isometric lines.
4. **Isometric plane:** The plane representing any face of the cube as well as other plane parallel to it is called an isometric plane. Here, ABCD, BCGF, CGHD, etc., are isometric planes.
5. **Non-isometric plane:** The plane which is not parallel to isometric planes are known as non-isometric planes. Here, the plane ABGH, CDEF, AFH, CFH, etc., are non-isometric planes.
6. **Isometric scale:** It is the scale which is used to convert the true length into isometric length. Mathematically, Isometric length = 0.816 X True length

6.5. CONSTRUCTION OF AN ISOMETRIC SCALE

Referring to Fig, 6.3. All the edges of the cube are equally foreshortened. Therefore, the square faces are seen as rhombuses in the isometric projection. The foreshortening of the edge can be calculated as follows:

In a triangle ABO, $\frac{BA}{BO} = \frac{1}{\cos 30^0} = \frac{2}{\sqrt{3}}$

In triangle A'BO, $\frac{BA'}{BO} = \frac{1}{\cos 45^0} = \frac{\sqrt{2}}{1}$

$$\text{Therefore, } \frac{\text{Isometric length}}{\text{True length}} = \frac{BA}{BA'} = \frac{2}{\sqrt{3}} X \frac{1}{\sqrt{2}}$$

$$= \frac{\sqrt{2}}{\sqrt{3}} = 0.816(\text{Approx})$$

This reduction of the true length can be obtained either by multiplying it by a factor 0.816

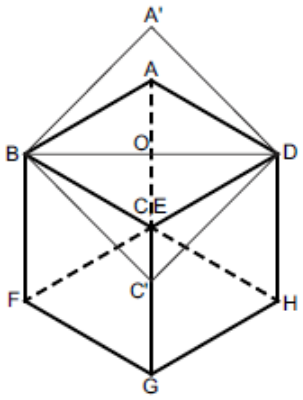


Fig.6.3:

6.6. CHARACTERISTICS OF PRINCIPAL LINES IN ISOMETRIC PROJECTION

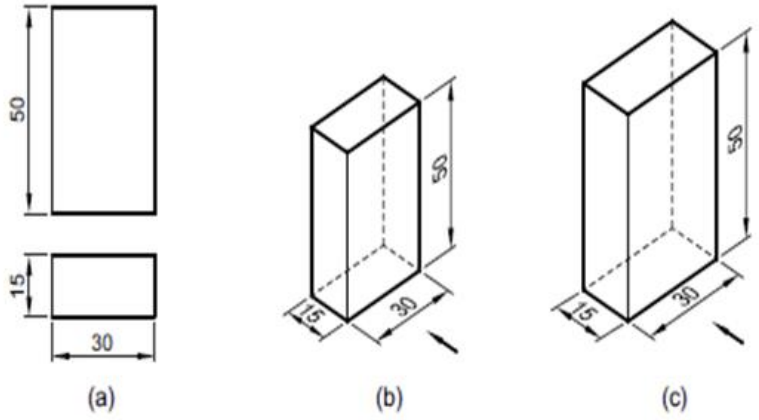
The following are the characteristics of the principal lines in an isometric projection:

1. All lines that are parallel on the object are parallel on the isometric projection.
2. Vertical line on the object remains vertical in the isometric projection.
3. The horizontal lines on the object are drawn at an angle of 30° with the horizontal.
4. The lines parallel to the principal lines known as isometric lines are equally foreshortened.
5. The lines which are not parallel to principal lines known as non-isometric lines are not equally foreshortened. For example, diagonals BD and AC are of equal lengths in front

view but are of different lengths in the isometric projection. The non-isometric lines are drawn by locating positions of their ends on isometric planes

6.7. ISOMETRIC PROJECTION AND ISOMETRIC VIEW

In an isometric projection, a scale factor of **0.816** is used to prepare the drawing whereas in an isometric view the true length is used. Thus, the isometric view of an object is larger than the isometric projection. Because of ease of construction and advantage of measuring the dimensions directly from the drawing, it has become a general practice to use the true lengths instead of isometric lengths. Figure (a) shows the orthographic views of a cuboid. Figure6.4. (b) shows its isometric projection whereas Fig. (c) Shows its isometric view. Thus, isometric projection looks smaller in size than the isometric view. It may be noted that, if it is desired to draw isometric view an object containing some spherical feature it is general practice to draw the isometric projection only



(a) *Orthographic projection* **(b)** *Isometric projection* **(c)** *Isometric view*

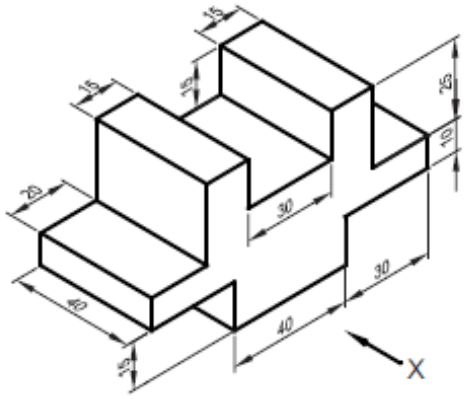
Fig.6.4:

6.8. DIMENSIONING ON ISOMETRIC PROJECTION

Following points should be remembered while dimensioning an isometric projection or view:

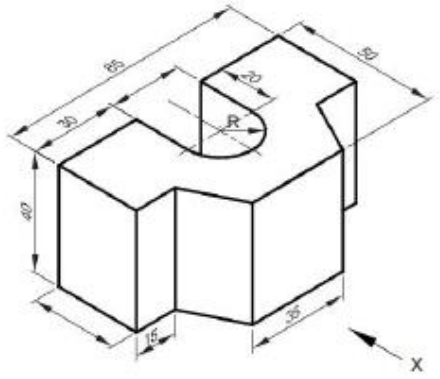
1. While dimensioning isometric projection or isometric view, the true length should be written for the dimension values.
2. As far as possible all extension lines and dimension lines must be isometric lines, lying in isometric planes.
3. It is usual practice to avoid the hidden lines unless they are essential to make the drawing clear.
4. Centre lines of the circular features should be drawn parallel to the isometric axis.
5. Dimensions for the circular feature should lie on the plane in which it appears to a greater extent

6.9. DRAW ISOMETRIC VIEWS OF THE FOLLOWING FIGURES



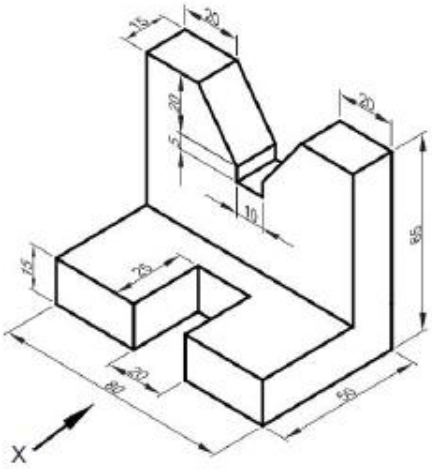
(a)

Fig. (a) *Pictorial view*



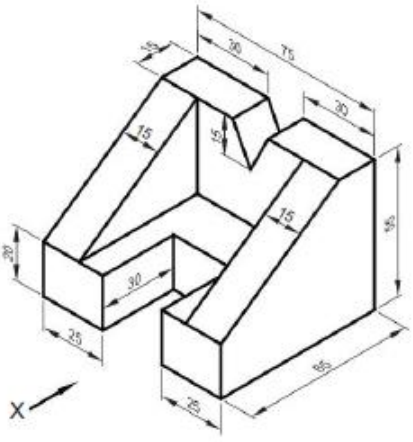
(a)

Fig. (a) *Pictorial view*



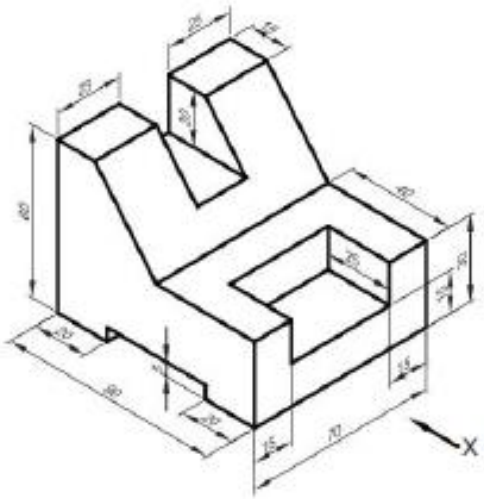
(a)

Fig. (a) *Pictorial view*



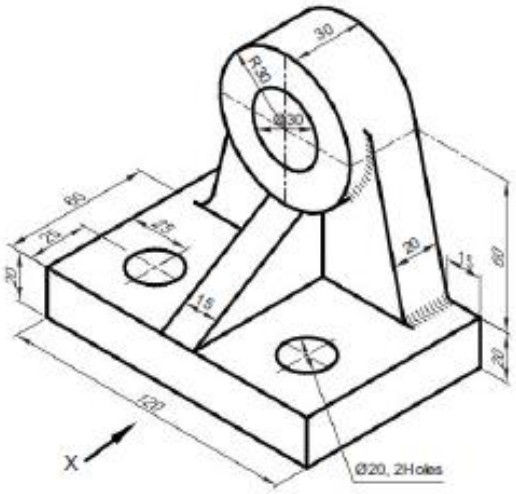
(a)

Fig. (a) *Pictorial view*



(a)

Fig. (a) *Pictorial view*



(a)

Fig. (a) *Pictorial view*