Sheet 12: ISOMETRIC PROJECTIONS

Introduction:

In engineering field, it is normal to draw two or more than two orthographic projections to give the shape and size of the object. Some time, less experienced technician often required hard exercise of the brain to visualize the orthographic projections. To make it easy to understand the shape of the object, it needs an additional view known as Isometric view. The isometric view represents the overall appearance of the object and makes it easy to understand some details which may be difficult to understand in the orthographic projections.

Isometric View:

The three dimensional view of an object obtained on a plane of projection in which all the projectors are parallel but inclined at an angle of 30° to the plane of projection is known as Isometric View. In this type of projection, the object is placed in such a way that all the three axes make equal angle with the plane of projection.

Theory of Isometric View:

It is important to know how an isometric view is obtained on the plane of projection? Consider a cube. Let the three corners of the cube meeting at the forward corner is equally inclined to the plane of projection so that the projection to be obtained should give equal length. Therefore, any line so inclined is known as isometric line and the projection thus obtained, represent isometric projection or view. As three edges meeting at a point are equally inclined to each other, hence, the angle between two adjacent edges is equal to 360/3 = 120°. The following figure shows the isometric view of a cube in which the edges are parallel to the three main axes.

It is seen from the following figure that when a line is inclined to the plane of projection, it does not give the exact size. It is very essential to know the proportion by which various edges of the cube are shortened. This can be found by means of a scale known as isometric scale.
Isometric scale:

The proportion by means of which the true distances are reduced to isometric distance is known as **Isometric Scale**.

**Construction Method of Isometric Scale:**

To get an accuracy in the Isometric projections, it is necessary to get isometric lengths from the true lengths. This can be done by constructing the Isometric Scale, Construction steps are:

i. Draw a horizontal line OM

ii. At point O, Draw a line OP at angle 45° as shown in the following figure

iii. At point O, Draw another line ON at angle 30° as shown in the following figure.

iv. Now mark the true lengths such as 1, 2, 3, 4, 5, 6 cm etc on the line OP.

v. Project points 1, 2, 3, 4, 5, 6 etc on line ON so that projectors are perpendicular to the line OM.
vi. Corresponding points on line ON, represents isometric lengths 1, 2, 3, 4, 5, 6 cm etc from the point O.

Figure : Isometric Scale

Note: It is observed graphically that the ratio of isometric length to the true length is about 0.815 times the actual length.

Some Important Terms: (above figure)

i. **Isometric Axes**: The three lines such as CA, CB and CC\(_1\) are called the isometric axes. The inclination between all the three axes is always 120° between the two adjacent axes.

ii. **Isometric plane**: The planes representing the various surfaces of an isometric view is know as isometric plane e.g. CAA\(_1\)C\(_1\), CC\(_1\)B\(_1\)B etc.

iii. **Isometric Lines**: The lines which are parallel to the isometric axes are known as Isometric lines e.g. AA\(_1\), CC\(_1\)BB\(_1\) etc.

iv. **Non Isometric lines**: The lines which are not parallel to the isometric axes are known as Isometric lines e.g. lines other than AA\(_1\), CC\(_1\)BB\(_1\) etc.

Difference between Isometric Projection and Isometric View:

**The Isometric Projection** means to draw always the Isometric sketch by using Isometric scale and the Isometric Scale must also be drawn along with the Isometric Projection.

**Isometric View** means to draw Isometric sketch not necessarily taking measurements from the Isometric scale and the Isometric Scale may or may not be drawn along with the Isometric Projection. In this case, measurements can be taken directly from the true
orthographic projections because there is little difference between the isometric lengths and true length.

Notes: (i) Always draw the Isometric Scale when it is mentioned in the question paper that draw the isometric projections.
(ii) Incase of Isometric View, Isometric Scale may or may not be drawn. Solution by both the methods is correct.

Solved Problems on Objects with Isometric Lines and Objects with non Isometric Lines:

Solved Problem 1: The following figure shows the Orthographic front and top view of an object. Draw its isometric view.

Figure: Isometric views of an Object
Solved Problem 2: Draw an isometric projection of an equilateral triangular prism having base edges of length = 35 mm and height = 50 mm its end parallel to H.P. and one of rectangular face parallel to V.P.

![Isometric projection of an equilateral triangular prism]

Solved Problem 3: Draw an isometric projection of a triangular prism lying on the ground on one of its rectangular face having its base edges = 30, and length of the prism as 60 mm.
Solved Problem 4: Draw an isometric projection of a triangular pyramid of 30 mm base edges and 50 mm height standing on its base vertically.

Solved Problem 5: Draw an isometric projection of a frustum of a triangular pyramid having axis vertical, base edges = 30 mm, top edge = 15 mm and height = 40 mm.
Solved Problem 6: Draw an isometric projection of a pentagonal prism of base edges 30 mm and height 60 mm. The axis being vertical and one of the rectangular face parallel to V.P. in front.

Solved Problem 7: Draw an isometric projection of a pentagonal prism of lying on the ground on one of its rectangular faces with base edges = 30 mm, length = 60 mm.
Solved Problem 8: Draw an isometric projection of a pentagonal pyramid having base edges 30 mm and height 70 mm, with its axis perpendicular to H.P.

Solved Problem 9: Draw an isometric projection of a frustum of pentagonal pyramid of base edges 20 mm. The height of the pyramid is 70 mm, with its axis perpendicular to H.P.
Solved Problem 10: Draw an isometric projection of a Hexagonal prism of base edges 25 mm. The height of the Hexagonal prism is 50 mm, having two of its rectangle faces parallel to V.P. and axis perpendicular to H.P.
Solved Problem 11: Draw an isometric projection of a Hexagonal prism of base edges 25 mm. The height of the Hexagonal prism is 50 mm, lying on the ground on its rectangular face with its axis to H.P.
Solved Problem 12: Draw an isometric projection of a Hexagonal pyramid of base edges = 30 mm. The height of the Hexagonal pyramid is 70 mm standing on H.P. with two of its base edges parallel to V.P.

Solved Problem 13: Draw an isometric projection of a frustum of a Hexagonal pyramid with top base edges = 30 mm and bottom face edges = 15 mm, axis perpendicular to H.P. Two of its base edges parallel to V.P. The height of frustum of the Hexagonal pyramid is 60 mm standing on H.P.

Solved Problem 14: A Hexagonal pyramid base edges = 30 mm, height = 60 mm, having its axis vertical and two of its base edges parallel to V.P., is standing vertically over the top face of
equilateral triangular prism of base edges = 105 mm and height = 20 mm, having one of its rectangular face parallel to V.P. Draw an isometric projection of the combination of solid.

Figure: Isometric projection of hexagonal pyramid

Solved Problem 16: The following figure shows the side view and front view of a machine Block. Draw the isometric view of the block.
Solved Problem 17: The following figure shows the side view and front view of a machine Block. Draw the isometric view of the block.
Figure Isometric view
Solved Problem 18: The following figure shows the side view and front view of a machine Block. Draw the isometric view of the block.

Front View

Side View

Figure 1  Isometric view
Solved Problem 19: The following figure shows the side view and front view of a machine block. Draw the isometric view of the block.
Solved Problem 20: The following figure shows the side view and front view of a machine Block. Draw the isometric view of the block.
Solved Problem 21: The following figure shows the side view and front view of a frustum of the hexagonal pyramid. Draw the isometric view of the block.

[Diagram of the frustum of a hexagonal pyramid with side and front views, and an isometric view]
Solved Problem 22: The following figure shows the side view and front view of an object. Draw the isometric view of the object.

Solved Problem 23: The following figure shows the side view and front view of an object. Draw the isometric view of the object.
Solved Problem 24: The following figure shows the top view and front view of a frustum. Draw the isometric view of the object.
Problem 25: The following figure shows the top view and front view of a cube over a circular disc. Draw the isometric view of the object.

Solved Problem 26: The following figure shows the Top view and front view of an object. Draw the isometric view of the object.
Isometric Projections of Plane Figures:

**Note**: All dimensions are to be taken from isometric scale

**Solved Problem 27**: Draw the isometric projection of a square having side 30 mm and its surface parallel to H.P.

**Steps of Construction**:
Take a horizontal line XY and on it take a point A on it.
At point A draw line AB and AD of length 30 mm making an angle of 30° with XY line.
Through B draw a line BC parallel to AD and through D draw a line DC parallel to AB.
These lines intersect each other at C.
Join BC and DC. ABCD is the required the isometric projection of a square.

![Isometric Projection of a Square](image)

**Figure 27: Isometric Projection of a Square**

**Solved Problem 28**: Draw the isometric projection of a circle having diameter 30 mm and its surface parallel to H.P.

**Steps of Construction**:
Take a horizontal line XY and on it take a point A on it.
At point A draw line AB and AD of length 30 mm making an angle of 30° with XY line.
Through B draw a line BC parallel to AD and through D draw a line DC parallel to AB.
These lines intersect each other at C.
Join BC and DC. Complete the ABCD square.
Mark the mid point of all sides of the square as H, F, G, and E.
Join AC, BD, EC, EF, HC, HG, AG, and AF.
Taking A as centre and radius AG or AF, Draw arc GF.
Taking C as centre and radius CE or CH, Draw arc EH.
Taking M as centre and radius MG or ME, Draw arc EG.
Taking N as centre and radius NH or NF, Draw arc HF.
Thus EHFG id the required isometric projection of a circle

**Figure**  
*Isometric projection of circle*

**Solved Problem 29**: Draw the isometric projection of a circle having diameter 30 mm and its surface parallel to H.P.

**Steps of Construction**:
1. Take a horizontal line XY and on it take a point B on it.
2. At point A draw line AB of length 30 mm making an angle of 30° with XY line.
3. Through point A, B draw lines AD = 30 mm, BC = 30 mm, both perpendicular to XY line.
4. Join DC to Complete the ABCD as isometric square.
5. Mark the mid point of all sides of the square as H, F, G, and E
6. Join AC, BD, EC, EF, HC, HG, AG, and AF.
7. Taking A as centre and radius AG or AF, Draw arc GF.
8. Taking C as centre and radius CE or CH, Draw arc EH.
9. Taking M as centre and radius MG or ME, Draw arc EG.
10. Taking N as centre and radius NH or NF, Draw arc HF.
Thus EHFG id the required isometric projection of a circle
Solved Problem 30: Draw the isometric projection of an equilateral triangle ABC having side 35 mm and its surface parallel to H.P.

Steps of Construction:
Take a horizontal line XY and on it take a point A on it.
At point A draw line AB, AF both of length 35 mm making an angle of 30° with XY line. Through points B, F draw lines FE parallel to AB and BE parallel to AF. These lines intersect each other at E. Join BE and FE, Complete the ABEF as isometric square. Mark the mid point of all side FE of the square as C.
Join ACB, this gives the required isometric projection of an equilateral triangle.
Solved Problem 31: Draw the isometric projection of an equilateral triangle ABC standing on the ground on its side $AB = 35$ mm

Steps of Construction:
Take a horizontal line XY and on it take a point A on it.
At point A draw line BA, of length 35 mm making an angle of $30^\circ$ with XY line.
Through points B, A draw lines BE and AE both perpendicular to XY and equal to 35 mm.
Join to AB and BE parallel to AF. These lines intersect each other at E. Join BE and FE,
Complete the ABEF as isometric square.
Mark the mid point of all side FE of the square as C.
Join ACB, this gives the required isometric projection of an equilateral triangle.

Figure

![Isometric projection of an equilateral triangle](image)

Solved Problem 32: Draw the isometric projection of a pentagon of 25 mm side length , lying on the H.P. with one of its sides parallel to V.P. and its surface parallel to H.P.

Steps of Construction:
Draw a pentagon ABCDE, with each side = 25 mm and enclose it in to a rectangle as shown in the helping figure.
Now draw the isometric projection of the rectangle formed in the helping figure by the usual method.
Mark the points A, B, C, D, and E of the pentagon on this isometric rectangle by taking measurements from the helping figure.
Join all these points to get isometric projections of a pentagon ABCDE.
Solved Problem 33: Draw the isometric projection of a pentagon of 25 mm side length, having its parallel to V.P and perpendicular to H.P.

Steps of Construction:
Draw a pentagon ABCDE, with each side = 25 mm and enclose it in to a rectangle as shown in the helping figure.
Now draw the isometric projection of the rectangle formed in the helping figure by the usual method keeping its two side perpendicular to XY line (perpendicular to H.P.).
Mark the points A, B, C, D, and E of the pentagon on this isometric rectangle by taking measurements from the helping figure.
Join all these points to get isometric projections of a pentagon ABCDE.
Solved Problem 34: Draw the isometric projection of a Hexagon of 25 mm side length having its surface parallel to H.P. and two its sides parallel to V.P.

Steps of Construction:
Draw a pentagon ABCDEF, with each side = 25 mm and enclose it in to a rectangle as shown in the helping figure.
Now draw the isometric projection of the rectangle formed in the helping figure by the usual method.
Mark the points A, B, C, D, E and F of the hexagon on this isometric rectangle by taking measurements from the helping figure.
Join all these points to get isometric projections of a hexagon ABCDEF.

![Isometric projection of a hexagon](image)

Solved Problem 35: Draw the isometric projection of a Hexagon of 30 mm side length standing on one of its sides, with parallel to V.P.

Steps of Construction:
Draw a pentagon ABCDEF, with each side = 30 mm and enclose it in to a rectangle as shown in the helping figure.
Now draw the isometric projection of the rectangle formed in the helping figure by the usual method keeping its two side perpendicular to XY line (perpendicular to H.P.).
Mark the points A, B, C, D, E and F of the hexagon on this isometric rectangle by taking measurements from the helping figure.
Join all these points to get isometric projections of a hexagon ABCDEF.
Figure Isometric projection of a hexagon
Q. No. 1  A frustum of hexagonal pyramid, base side 30 mm, top side 20 mm, axial height 60 mm, is resting on its base in the H.P. One base side is parallel to the V.P. Draw its isometric projection.
Q. No. 2 Draw the isometric view of the object shown by its two views in the following figure.

Q. No. 3 Draw the isometric view of the object shown by its two views in the following figure.
Q. No. 4 Following figure shows two orthographic views of a hollow cube placed centrally over a cylindrical disc. Draw the isometric projection of the combined solid.
Q. No.5 Plan, elevation and side view of a casting are shown in the following figure. Draw its isometric view.