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# ***CONCEPTS.***

Isometric projections are 3-D representation of objects. Since we deal mostly with solids which are 3-D objects, we use isometric projections for representation of figures having length (l), breadth (b) and height (h).

**Angles** used in **Isometric Projections**: ***$30^0$----$30^0$------$90^0$***

There are two cases of questions in isometric projections. They are as follows:

1) Simple solids like prisms and pyramids are given with their axis position specified in the problem. We have to draw the isometric projections.
2) 2-D views (front view, top view and side views) of some solids are given. From the analysis of the figure, we have to generate the 3-D model using $30^0$—$30^0$—$90^0$ angles for l, b & h.

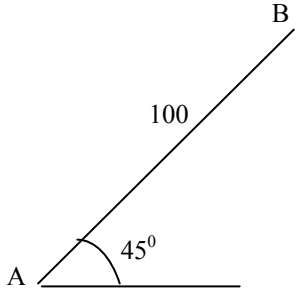
Here, we start with the first case and solve all the different cases of prisms and pyramids with axis in vertical or horizontal positions.

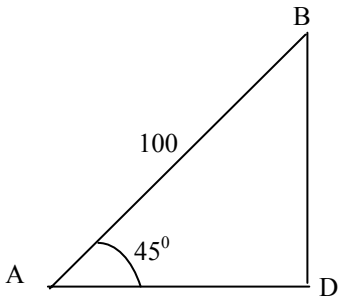
1) Define isometric scale. Draw the isometric scale and show the relation between the true length and isometric length.

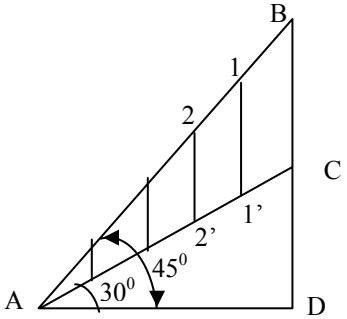
Ans) Isometric scale is the scale which gives the ratio between the true length and isometric length.

(i) To draw the isometric scale, consider a true length (AB) of 100 mm.
(ii) The true length is drawn at $45^0$ with the horizontal and a right angle triangle (ABD) is constructed.
(iii) At A, draw a line at $30^0$ to cut BD at C. AC will directly give the Isometric length.
(iv) From the right angle triangles ADB and ADC, we get the ratio between isometric length and true length as 0.8.
(v) Mark a few points 1, 2, 3...on AB at equal distances and project vertically on AC to get the isometric lengths of 1', 2', etc.

The steps of construction are shown step by step in the following figures.




**Isometric length/ true length = AC/ AB = Cos $45^0$ / Cos $30^0$ = 0.8**

***Isometric length = 0.8 * True Length***

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## ***Isometric projections of Prisms***

In all isometric projections of solids like prisms, pyramids, cylinders and cones, there are two positions of axis. They are as follows:

(i) ***Axis Vertical***: Base (Box) is drawn at $30^0$- $30^0$ and the height (Axis) is drawn at $90^0$.
(ii) ***Axis Horizontal***: Base (Box) is drawn at $30^0$- $90^0$ and the height (Axis) is drawn at $30^0$.
If box is $30^0$ left, then axis is $30^0$ right & if box is right, axis is left.

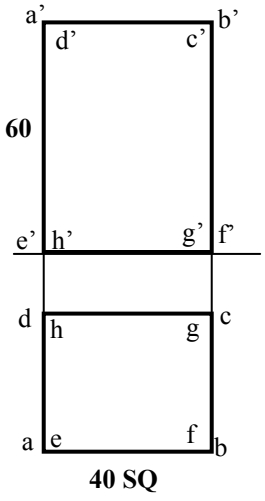
**Procedure for drawing Isometric projections of Prisms**:

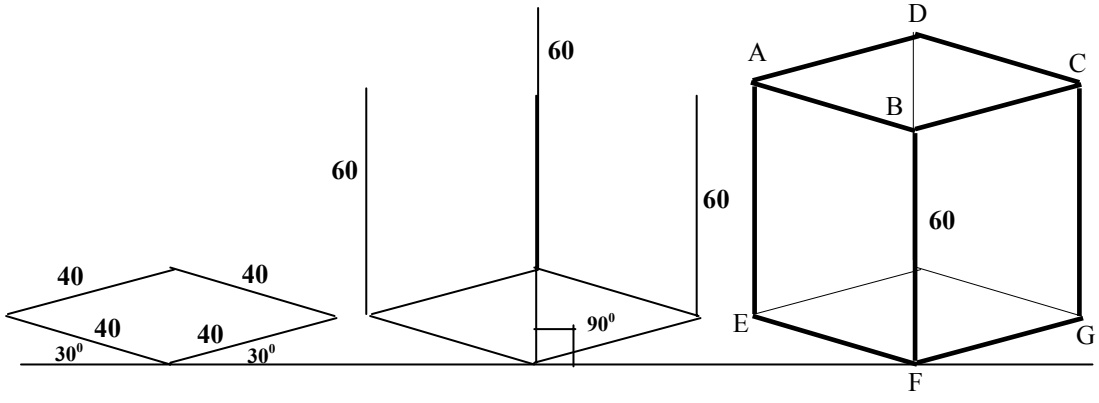
1) Draw the orthographic view of the solid with the axis vertical or horizontal.
2) Around the polygon of base (pentagon, hexagon, etc) draw a box touching all the vertices or corners.
3) Depending on the axis position (Vertical or horizontal), draw the box of same measurements at $30^0$-$30^0$ or $30^0$-$90^0$.
4) In the top view, measure the distances of each vertex from the corners of the box & cut arcs of same distances in the isometric box.
5) Join all the arcs to get the required polygon base in isometric view.
6) From each corner, draw vertical lines (if axis is vertical) of length equal to axis and join them to get the required prism.
7) If the axis is horizontal, then the base box is drawn at $30^0$-$90^0$ (left) & the lines are drawn at $30^0$ (right) of length equal to axis and join them in sequence to get the horizontal prism.
8) Only visible parts are to be shown dark and all other hidden parts are erased or shown very light.

Q2) A square prism of base 40 mm sides and axis 60 mm has its base on the ground & axis ‖ to VP (⊥ to HP). Draw **the isometric projection of the square prism**.

Ans) Since the axis is vertical (base lying on the ground --→ axis ⊥ to HP), draw base at $30^0$-$30^0$ & axis at $90^0$.

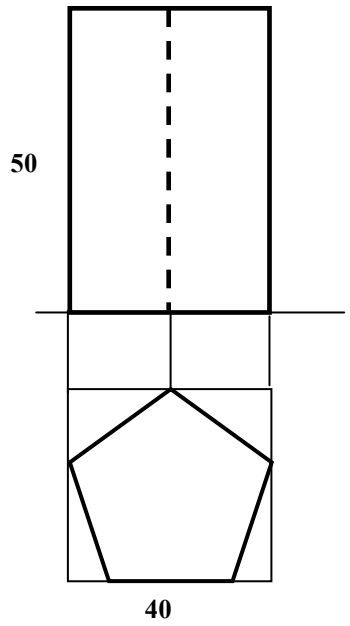
The construction is shown step wise and final figure is obtained. Steps are for understanding. Only the final figure is to be drawn in every solution.

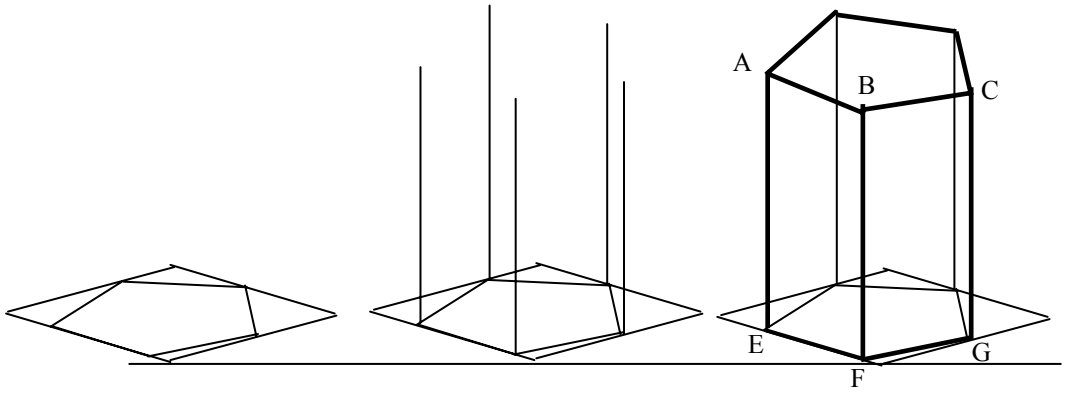


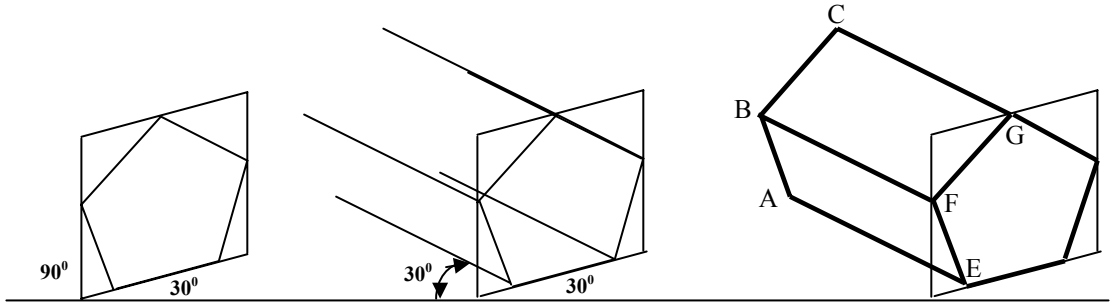



Q3) A pentagonal prism of base 25 mm sides and axis 50 mm long is resting on the ground on its base. Draw its isometric projections.

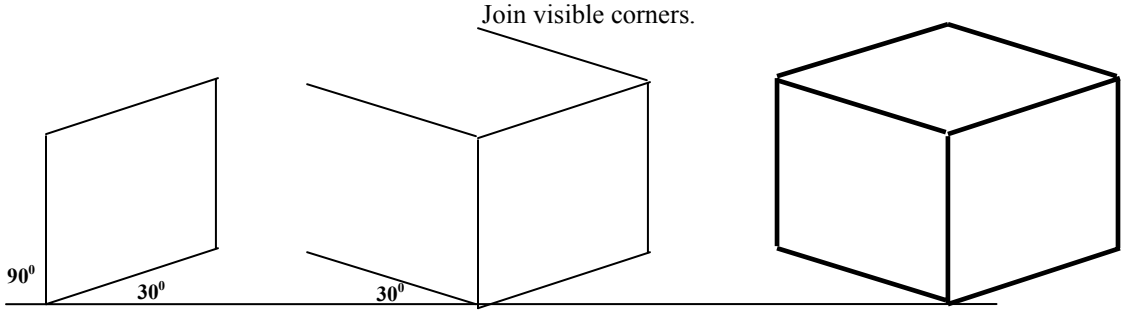
Ans) Since the axis is vertical, the pentagon is to be drawn at 30-30 in isometric view by box method.




Box at $30^0$-$90^0$ (right) Axis at $30^0$ left (50 mm) Join visible corners. Completed Prism.




Box at $30^0$-$90^0$ (right) Axis at $30^0$ left (50 mm) Join visible corners. Completed Square Prism. When axis is horizontal.

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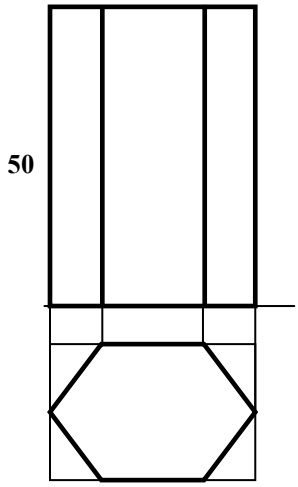
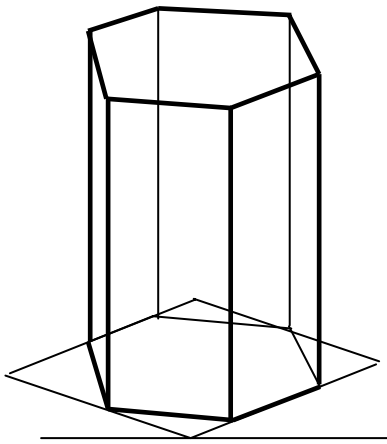
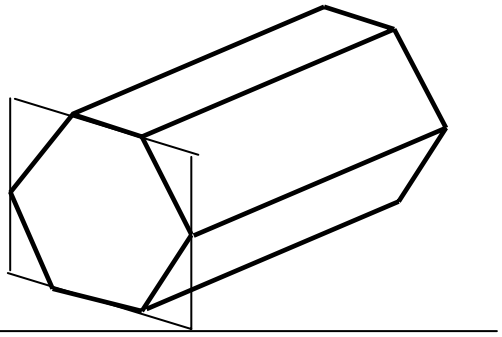
Q4) Draw the isometric view of a hexagon of base 30 mm sides and axis height 50 mm when its axis is (i) horizontal & (ii) Vertical (pointing towards the viewer).

Ans) Since the two positions are required, the box is drawn at $30^0$-$90^0$ in 1st case and $30^0$-$30^0$ in 2nd case.



Box at $30^0$-$30^0$
Axis at $90^0$ (50 mm)
Completed Prism.



Box at $30^0$-$90^0$ (left)
Axis at $30^0$ right (50 mm)
Completed Prism

**Procedure for drawing Isometric projections of Pyramids**:

1) Draw the orthographic view of the solid with the axis vertical or horizontal.
2) Around the polygon of base (pentagon, hexagon, etc) draw a box touching all the vertices or corners.
3) Depending on the axis position (Vertical or horizontal), draw the box of same measurements at $30^0$-$30^0$ or $30^0$-$90^0$.
4) In the top view, measure the distances of each vertex from the corners of the box & cut arcs of same distances in the isometric box.
5) Join all the arcs to get the required polygon base in isometric view.
6) From center of the polygon, draw vertical line (if axis is vertical) of length equal to axis and join the corners of the polygon base to this apex point to get the required pyramid.
7) If the axis is horizontal, then the base box is drawn at $30^0$-$90^0$ (left) & the axis is drawn at $30^0$ (right) of given length and join the apex point to all corners of the polygon base to get the horizontal pyramid.
8) Only visible parts are to be shown dark and all other hidden parts are erased or shown very light.

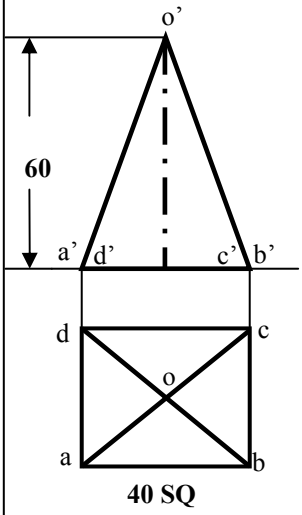
Q5) A square pyramid of base 40 mm sides and axis 60 mm has its base on the ground & axis ‖ to VP (⊥ to HP).

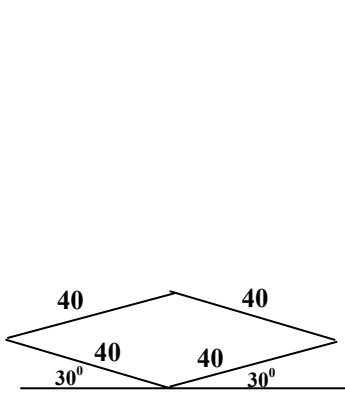
(i) Draw **the isometric projection of the square pyramid.**

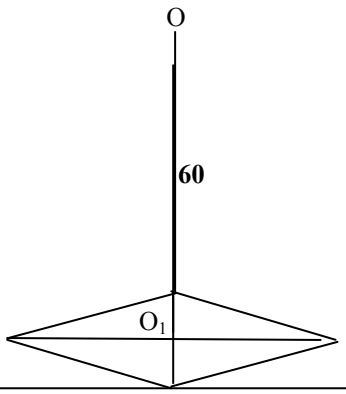
(ii) Also draw the isometric projection of the pyramid when its axis is horizontal.

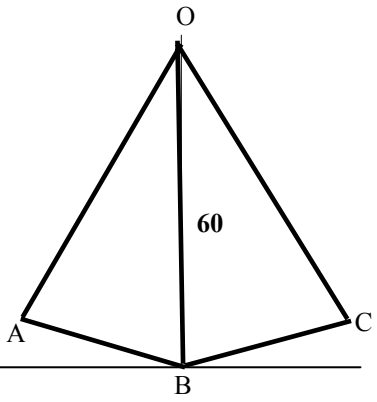
Ans) Since the axis is vertical (base lying on the ground --→ axis ⊥ to HP), draw base at $30^0$-$30^0$ & axis at $90^0$.

The construction is shown step wise and final figure is obtained. Steps are for understanding. Only the final figure is to be drawn in every solution.

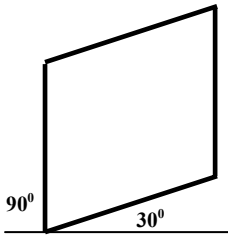


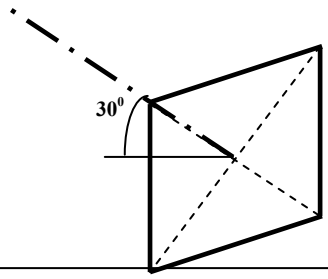



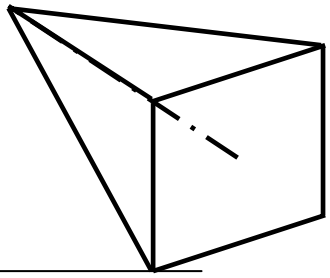

$O_1O$ = 60 (axis is from centre of base)




Box at $30^0$-$90^0$ (right)



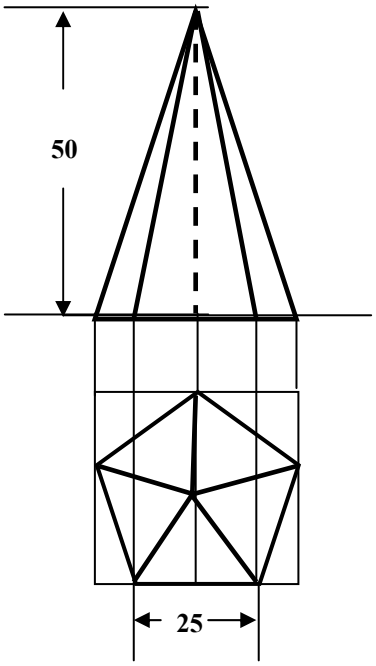

Axis at $30^0$ left (60 mm from centre)
Join visible corners.

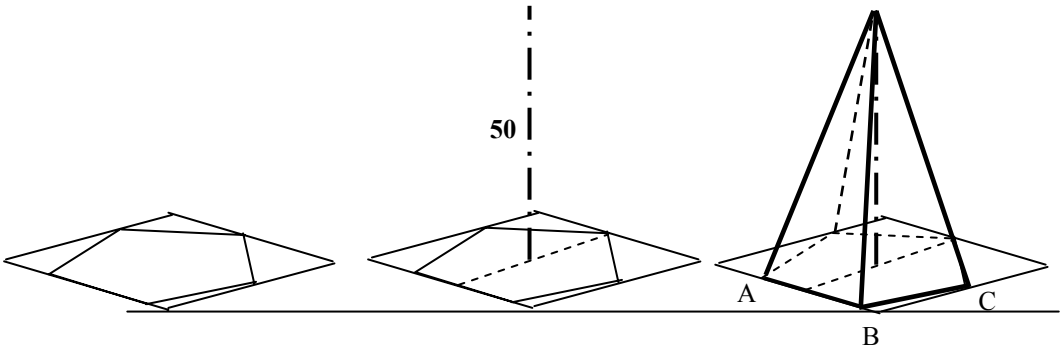


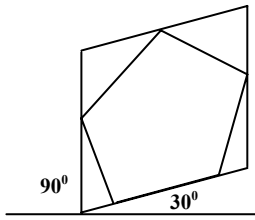
Completed Square Pyramid.

Q6) A pentagonal prism of base 25 mm sides and axis 50 mm long is resting on the ground on its base. Draw its isometric projections.

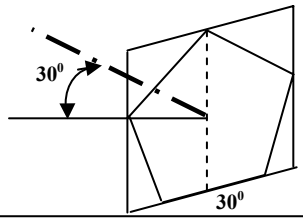
Ans) Since the axis is vertical, the pentagon is to be drawn at 30-30 in isometric view by box method.



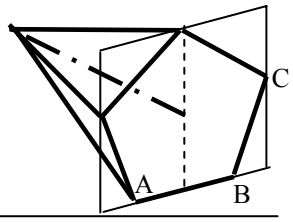




Box at $30^0$-$90^0$ (right)

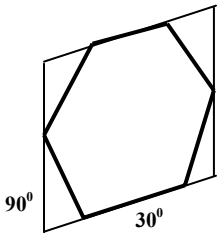



Axis at $30^0$ left (50 mm from center)

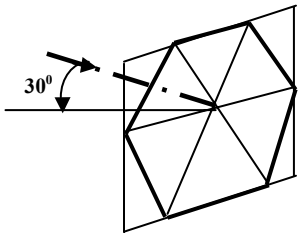



Join visible corners
Completed Pyramid

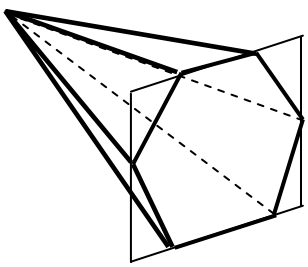
**Hexagonal Pyramid when axis is horizontal**:




Box at $30^0$-$90^0$ (right)




Axis at $30^0$ left (50 mm)
Join visible corners.



Completed Hexagonal Pyramid

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## ***Isometric projections of Cylinders& Cones***

In all isometric projections of cylinders and cones, there are two positions of axis. They are as follows:

(i) ***Axis Vertical***: Base (Box) is drawn at $30^0$- $30^0$ and the height (Axis) is drawn at $90^0$.

(ii) ***Axis Horizontal***: Base (Box) is drawn at $30^0$- $90^0$ and the height (Axis) is drawn at $30^0$. If box is $30^0$ left, then axis is $30^0$ right & if box is right, axis is left.

Note: The base of the cone or cylinder is a circle and appears as an ellipse in the isometric projection. Hence it is drawn by ***4-Centre V method***.

**Procedure for drawing Isometric projections of Cylinders & Cones**:

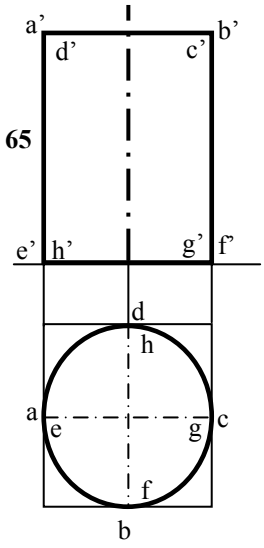
1) Draw the orthographic view of the solid with the axis vertical or horizontal.
2) Around the polygon of base (circle) draw a box (Square) touching the circumference of the circle.
3) Depending on the axis position (Vertical or horizontal), draw the box of same measurements at $30^0$-$30^0$ or $30^0$-$90^0$.
4) In 4-C V method, first mark the 4 mid points (centers) of the square box. Join corners to opposite centers to get V shape lines.
5) From each corner of V, draw arcs with V as center and radius as length of V (corner to center distance). Total 4 V's are used and an ellipse is formed.
6) Draw vertical lines (if axis is vertical) of length equal to axis and join them at the top to form a Box again and in that use 4-C-V method to get another ellipse. Join the centers of symmetry of both the ellipses to get the isometric view of the required Cylinder.
7) If the axis is horizontal, then the base box is drawn at $30^0$-$90^0$ (left) & the lines are drawn at $30^0$ (right) of length equal to axis and join them in sequence to get the box and again in it use 4-C-V to get the Ellipse. Join the ellipses at their centers of symmetry to get the cylinder in horizontal position.

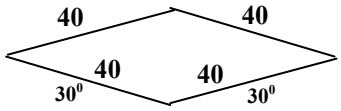
8) For Cones, the apex point is drawn from the centre and centers of symmetry of ellipse base are joined to get the required cone.
9) Only visible parts are to be shown dark and all other hidden parts are erased or shown very light.

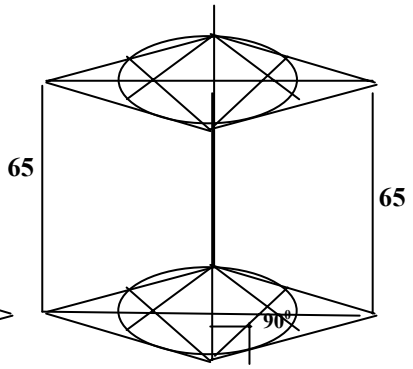
Q7) Draw the isometric projection of a cylinder of base 40 mm diameter and axis 65 mm long when its axis is
(i) Vertical (ii) Horizontal

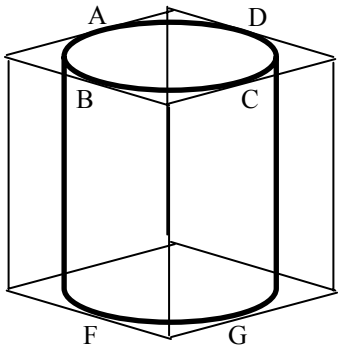
Ans) (i) Since the axis is vertical (base lying on the ground --→ axis ⊥ to HP), draw base at $30^0$-$30^0$ & axis at $90^0$.

The construction is shown step wise and final figure is obtained. Steps are for understanding. Only the final figure is to be drawn in every solution.

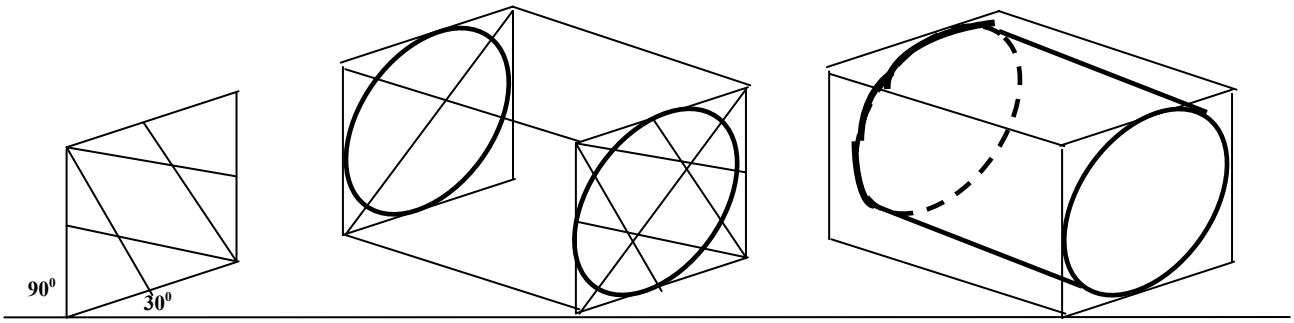



(ii) Axis Horizontal: Box is at $30^0$-$90^0$ & ***V is from next vertex from corner of reference line***.

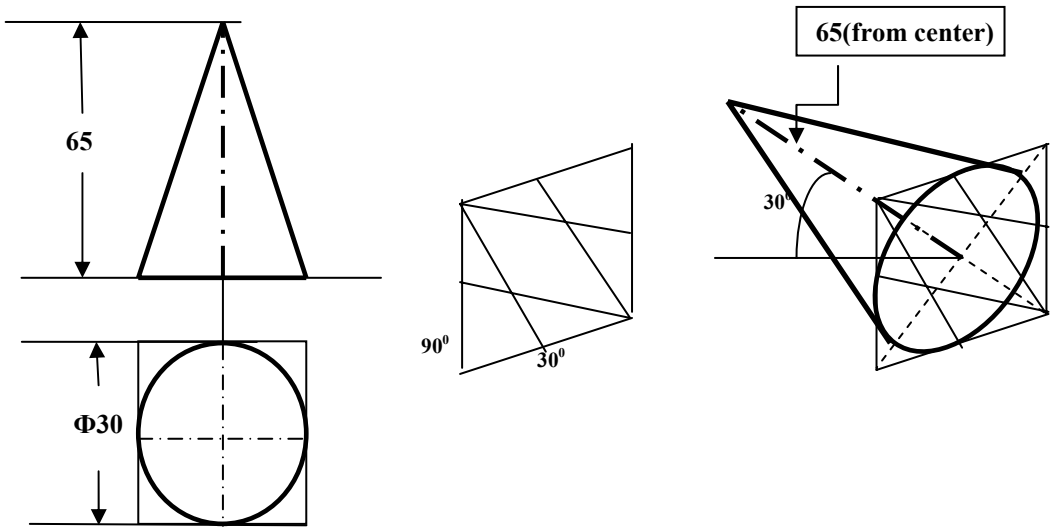


Q8) Draw the isometric projection of a cone of base 30 mm diameter and axis height 50 mm when its axis is (i) horizontal (tip is away from the viewer)
(ii) Vertical (pointing towards the viewer).

Ans) Since the two positions are required, the box is drawn at $30^0$-$90^0$ in 1st case and $30^0$-$30^0$ in 2nd case.

Use the same **4 centre V method** to draw the ellipse and height is to be taken from the centre of the box just like the case of pyramids.

***(i) Axis is Horizontal***




***(ii) Axis is Vertical***