

Chapter 7

ISOMETRIC PROJECTION

7.1 INTRODUCTION

Have you ever noticed that every corner of the class room, bed room, drawing room has three mutually perpendicular lines. These three lines give us the feeling of solid (3 dimensions).

Let us take the example of small boxes e.g. Chalk box, which are kept in front of us. If we keep the box in such a manner that its two vertical faces and one horizontal base will be visible to us in the equiangular position at one corner then it give us feeling of solid.

So we can say that if a solid is placed in such a position that its three edges are equally inclined at an angle of 120° , then the solid is placed, said to, in isometric position and this view is called ISOMETRIC PROJECTION.

Let us recall that the Orthographic Projection as one of the best way, to represent the details of any object, i.e. by principal planes of projection (HP & VP) held mutually at right angles to each other. We know that a simple machine block in standard views like Front view, Top view and Side view will look like as shown in Fig. 7.2(a).

But these views can be interpreted only by experienced persons with technical knowledge. So in an easier way, any object can be represented by a single view/drawing that shows all the faces of the object, as they appear to the observer and give us feeling of 3-D view. The solid considered above will look like Fig. 7.2(b) in single plane method.

Thus ISOMETRIC PROJECTION is yet another method to represent the details of any object in simplest way. Let us find out ! How?



Fig. 7.1

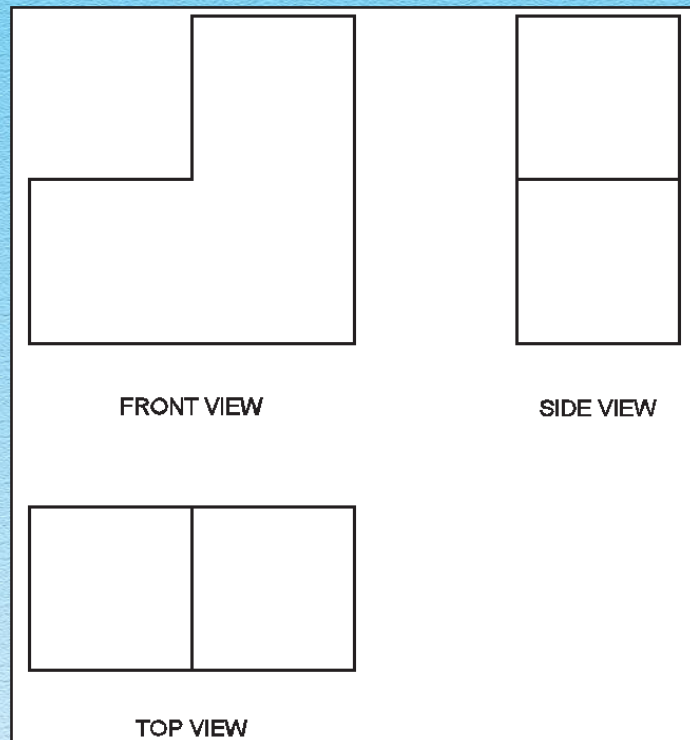


Fig. 7.2(a)

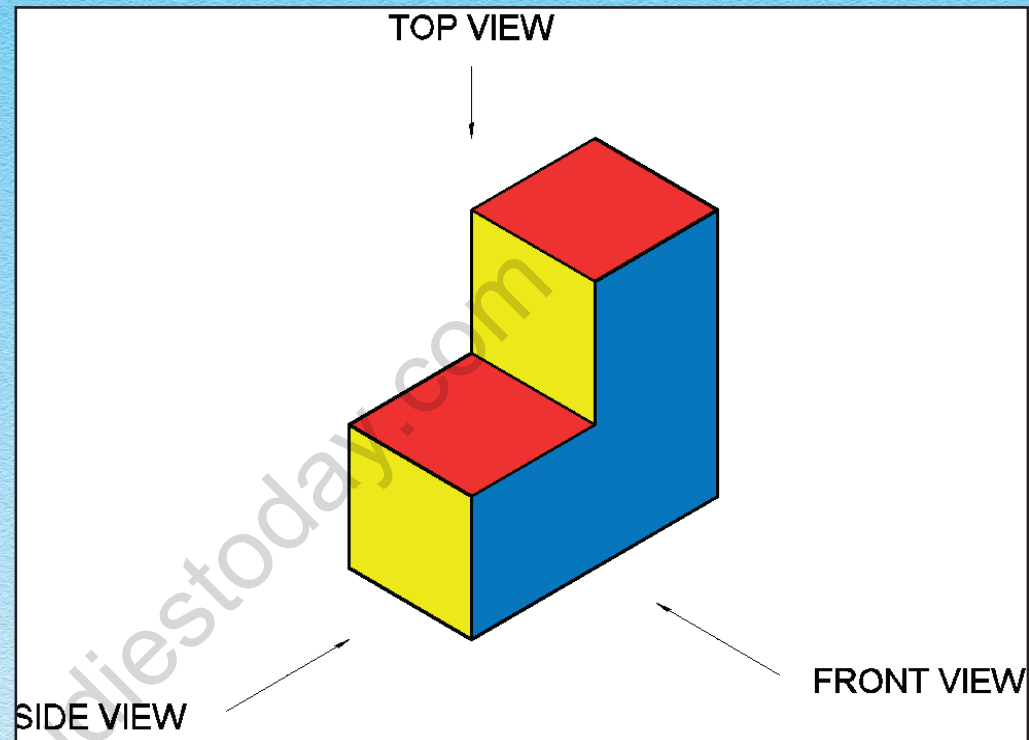


Fig. 7.2(b)

7.2 ISOMETRIC PROJECTION

The isometric projection of an object is a typical pictorial projection, drawn, with the object, So placed with respect to the planes of projection that all the three axes of the object are equally inclined to each other. Let us consider a cube [Fig 7.3(a)], for example, and draw its orthographic projections as in Fig. 7.3(b).

Now turn the cube so that all the faces are equally inclined i.e. 45° to V.P. and draw its views as shown in Fig. 7.4. Here are the Front View and Side View, both show two surfaces of the cube, parallel to the plane of projection. We can see the "Body Diagonal" in its Side View, which is the longest straight line that can be drawn in a cube.

Now raise the cube up, from rear base corner of the cube, upto that level, where the Body Diagonal becomes horizontal. Let us draw

its views. Here again we find two surfaces of cube in its Side View, while Front View shows all the three faces with all the three principal axes equally inclined to the plane of projection. So the Front View of Fig. 7.5 is the desired view, which is easy to understand as well as shows all the three dimensions in a single view. This Front View is popularly known as ISOMETRIC PROJECTION.

Direction of viewing for the object will be marked as shown and it has importance to verify the position of the observer with respect to V.P. and H.P.

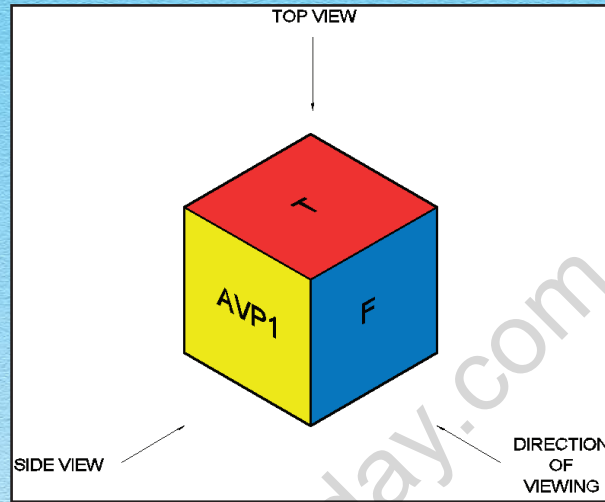


Fig. 7.3(a)

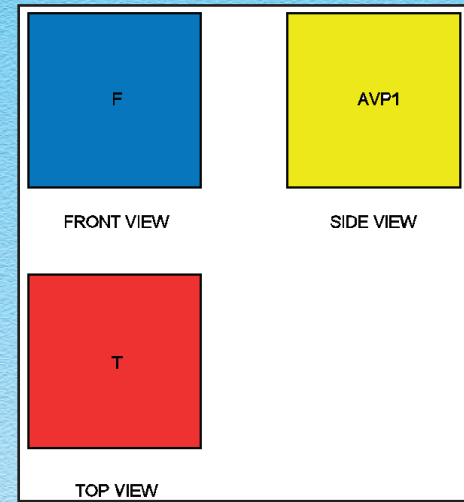


Fig. 7.3(b)

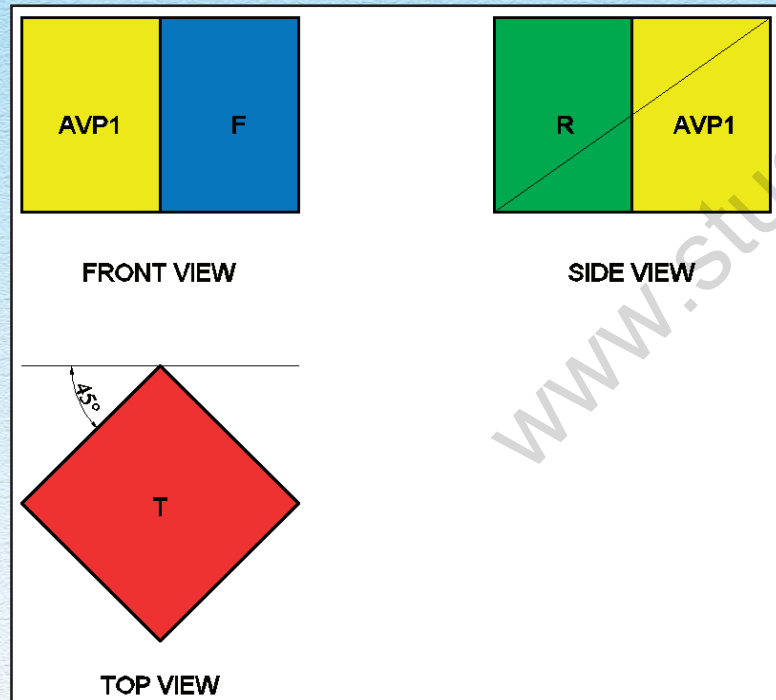


Fig. 7.4

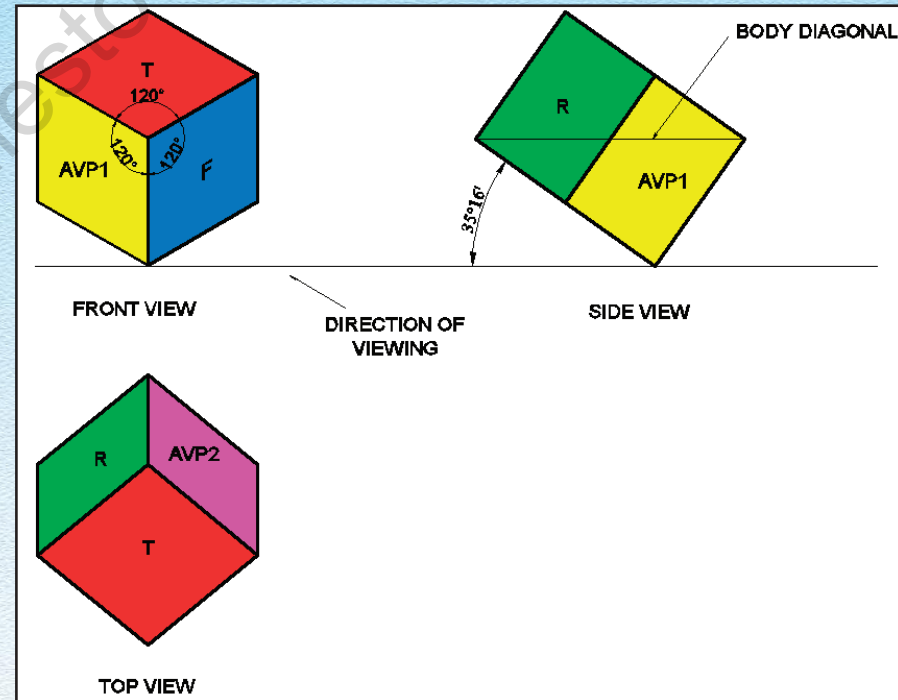


Fig. 7.5 (a & b)

DO YOU KNOW?

The cube is first turned at 45° from V.P. and in second stage it is rotated exactly at $35^\circ 16'$ with H.P to get the Isometric Projection.

7.3 ISOMETRIC SCALE

In section 7.2, we observed that isometric projection is drawn after keeping the object at specified angle to V.P. & H.P. and when the object is inclined to both the planes then the edges drawn in the isometric projection will be foreshortened with reference to true length. As in isometric projection the three principal axes form equal angles of 120° to each other, so only one scale is needed for measurement along each of the axes. The scale used to measure isometric length is called ISOMETRIC SCALE. To find out the ratio of foreshortening, Let us consider the Front View (Isometric Projection) in Fig. 7.5(a),

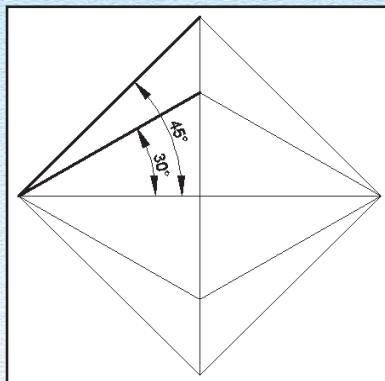


Fig. 7.6(a)

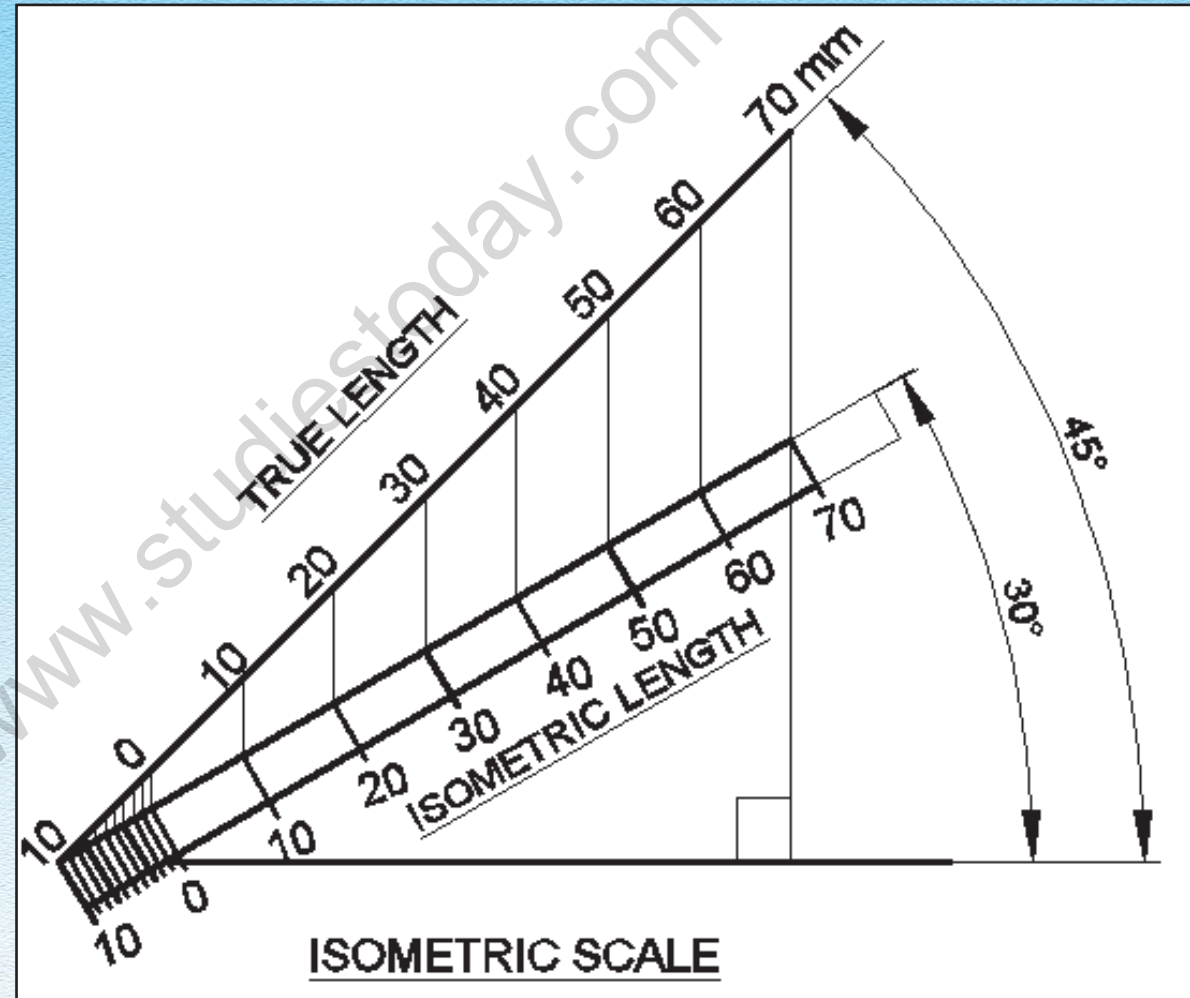


Fig. 7.6(b)

where the top (T) of the cube appears as a rhombus while in Fig. 7.4 the true shape of top (T) is square. These two shapes reveal that all the four edges of the Top (T) are foreshortened in isometric projection. If we draw both the (T) top relatively one with the other, we can conclude that rhombus edge is the isometric length of the square edge as shown in Fig. 7.6(a).

Geometrically isometric scale can be drawn as follows:

Steps of Construction :

- (i) Draw a horizontal line.
- (ii) From any point on horizontal line draw two lines inclined at 30° and 45° respectively.
- (iii) Mark the divisions on 45° line of one mm upto first 10 mm from starting point and then mark divisions after every 10 mm of required length, say 70 mm.
- (iv) These divisions are transferred by vertical lines (i.e. at 90° to the horizontal line) upto the 30° inclined line.
- (v) The scale projected on 30° line will give the isometric length.

Fig. 7.6 (b) shows the isometric scale.

DO YOU KNOW?

The value of isometric length can also be calculated mathematically w.r.t. true length. Copy the 1/4 part of the Fig. 7.6(a)

$$\text{Consider the right angle } \triangle ABC, \frac{AB}{AC} = \cos 30^\circ = \frac{\sqrt{3}}{2}$$

$$\text{Consider the right angle } \triangle ABD, \frac{AB}{AD} = \cos 45^\circ = \frac{1}{\sqrt{2}}$$

$$\text{Or, } \frac{AB/AD}{AB/AC} = \frac{\cos 45^\circ}{\cos 30^\circ} = \frac{1/\sqrt{2}}{\sqrt{3}/2}$$

$$\text{Or, } \frac{AC}{AD} = \frac{2}{\sqrt{2} \times \sqrt{3}} = \frac{\sqrt{2}}{\sqrt{3}} = 0.8$$

$$\text{Or, Isometric Length} \cong 0.8 \times \text{True Length}$$

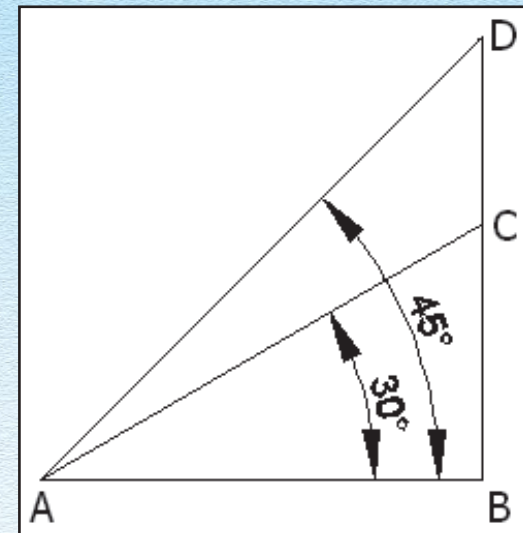


Fig. 7.6(c)

7.4 ISOMETRIC LINES

All those lines which are parallel to any of the three principal axes are called isometric lines. These can be taken directly for the value in isometric drawing (see Fig. 7.7).

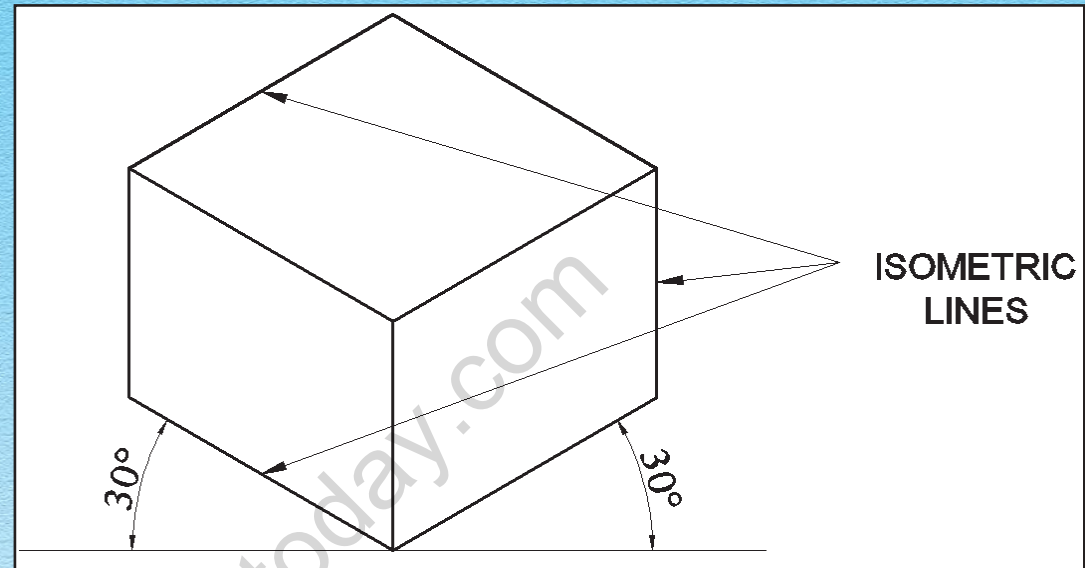


Fig. 7.7

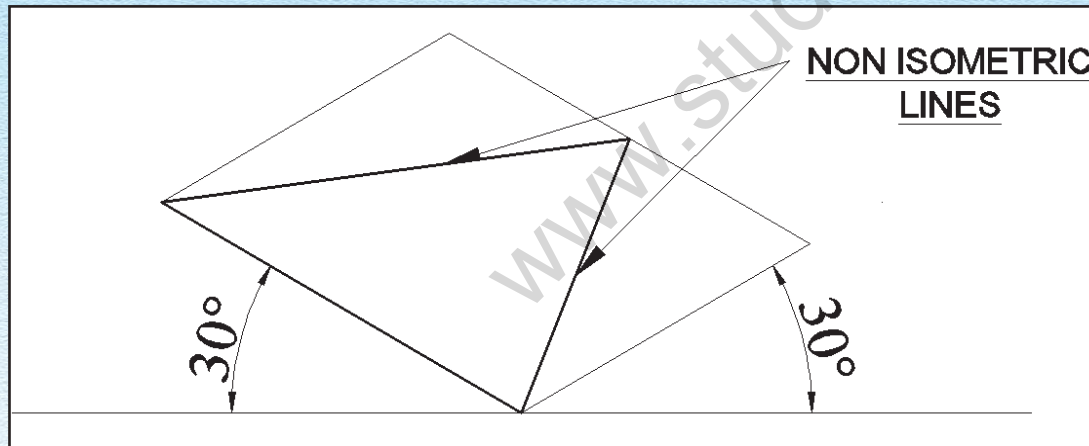


Fig. 7.8

7.5 NON ISOMETRIC LINES

All those lines which are not parallel to any of the principal axes are called non isometric lines. "These are drawn by finding the location of their two ends along principal axes and then by joining them. Non isometric lines and the angles between them do not show in their true values so can not be measured directly in isometric drawing." (see Fig. 7.8)

7.6 DRAWING TECHNIQUES FOR ISOMETRIC PROJECTION OF LAMINAE

As the isometric projection is the single plane projection as discussed in section 7.2, Do we have to turn every object in the same way? No, instead of turning, we can draw the object with respect to the three principal lines. The position of the principal lines in the isometric projection is discussed in Table 7.1.

PRINCIPAL LINE	ISOMETRIC PROJECTION	
	POSITION OF LINE	LENGTH
Perpendicular to H.P.	Vertical (90° line)	Isometric Length
Perpendicular to V.P.	Inclined (30° line)	
Perpendicular to P.P.	Inclined (30° line in other direction)	

Table 7.1 Isometric Projections of Principal Lines

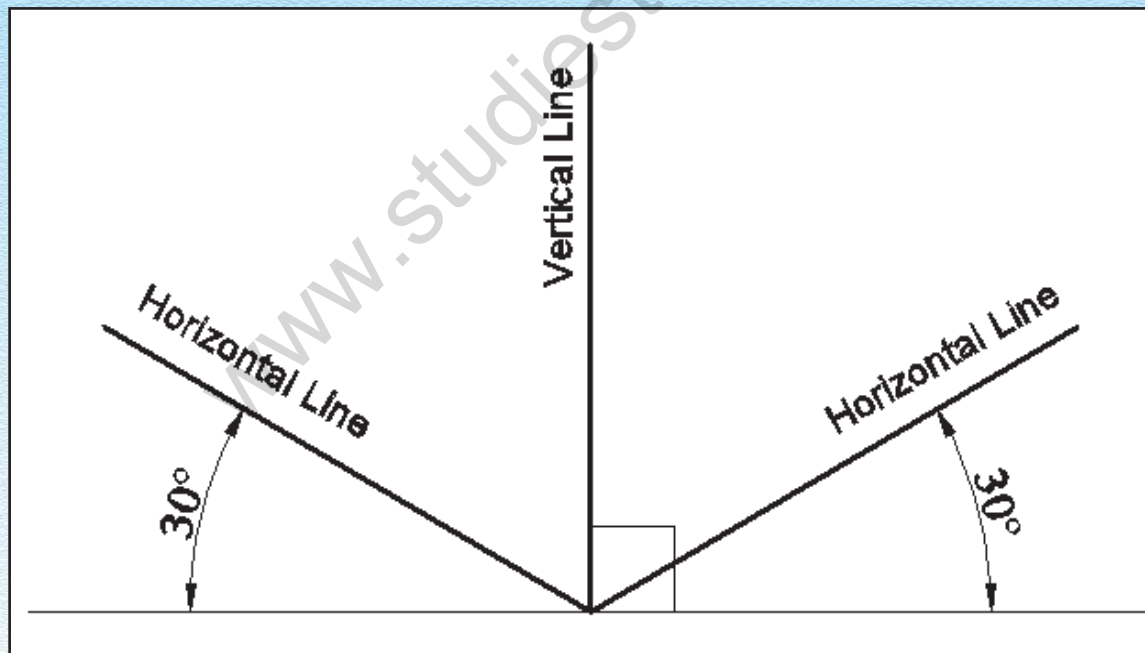


Fig. 7.9

If we consider two principal axes, at one time, they will represent H.P. & V.P. as follows.

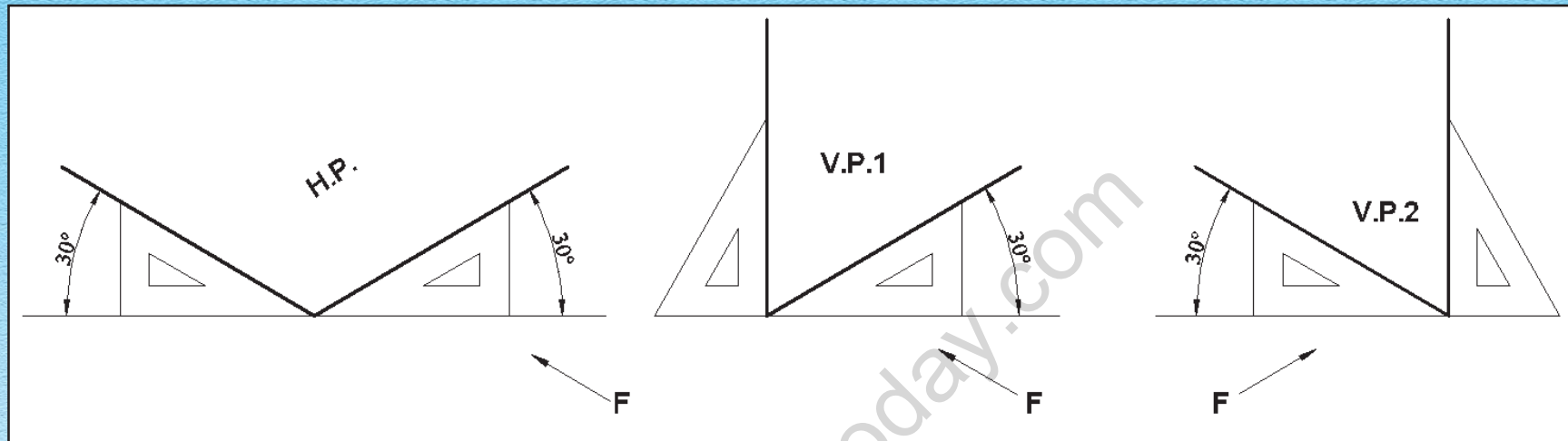


Fig. 7.10

The choice of V.P.₁ & V.P.₂ depends on the direction of viewing.

7.6.1 STEPS TO DRAW ISOMETRIC PROJECTION

- (i) Draw the lamina, (Helping Fig.) by using isometric length.
- (ii) Draw the centre of lamina.
- (iii) Enclose the Fig. in a box, just to fit in, by thin horizontal and vertical lines.
- (iv) Transfer all the points of lamina and centre onto the box lines.
- (v) Draw two principal axes, as desired, V.P. or H.P.
- (vi) Copy the dimensions of box to the principal axes.
- (vii) Complete the isometric projection box, by parallel lines.
- (viii) Copy all the points of lamina (helping Fig.) to the isometric box (called crate).
- (ix) Finish the isometric projection of lamina with visible lines, dimensioning and direction of viewing (F).

7.6.2 DIMENSIONING

Dimensioning in isometric projection is done as follows (Fig. 7.11).

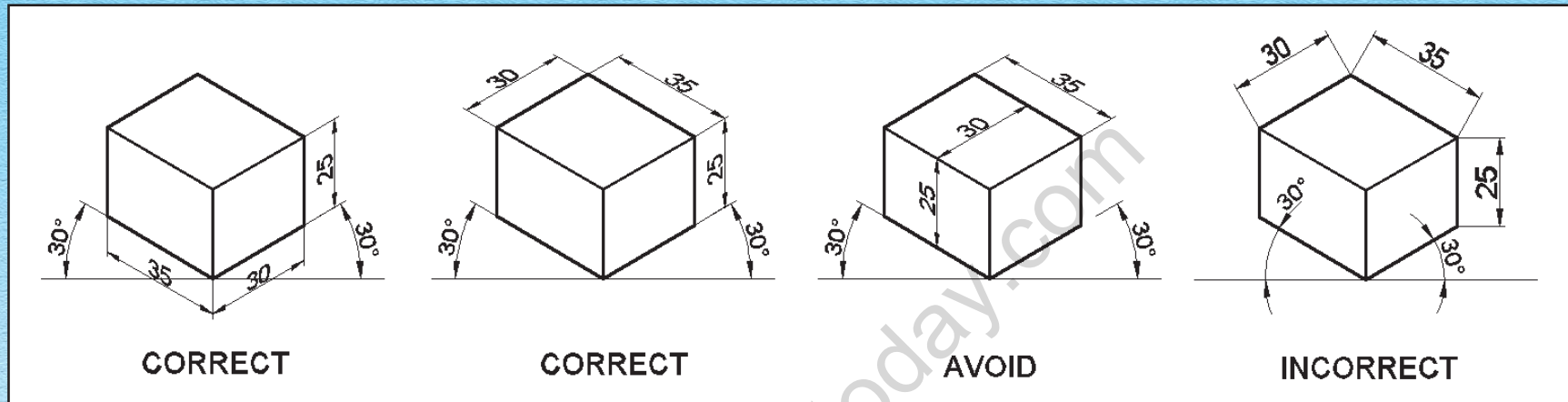


Fig. 7.11

Example 7.1 : Draw the isometric projection of an equilateral triangle of base side 60 mm in H.P.

Solution : Refer to Fig. 7.12

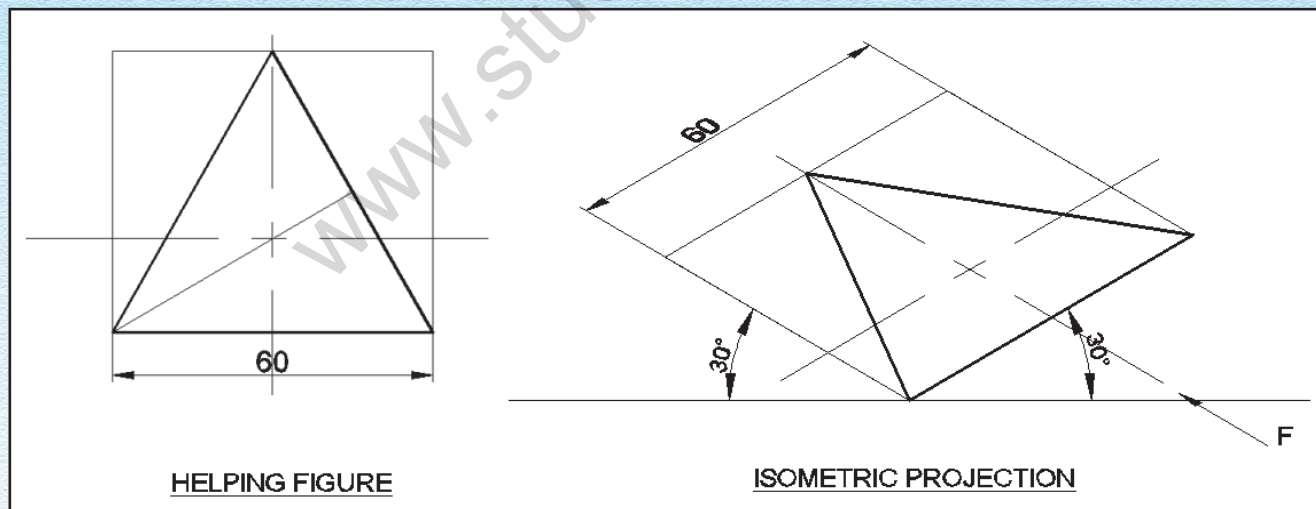


Fig. 7.12

Steps :

- (i) Draw a regular triangle of 60 mm isometric length and mark its centre.
- (ii) Enclose it in a box and transfer points onto the box lines to complete the helping Fig..
- (iii) Draw two principal axes along 30° and 30° lines as horizontal lines, in H.P.
- (iv) Copy the dimensions of box on isometric projection and complete it.
- (v) Copy all the points of helping Fig. box on to the isometric box.
- (vi) Draw the visible lines, dimensioning and direction of viewing (F).

Example 7.2 : Draw the isometric projection of an equilateral triangle of side 60 mm in V.P.

Solution : Refer to Fig. 7.13

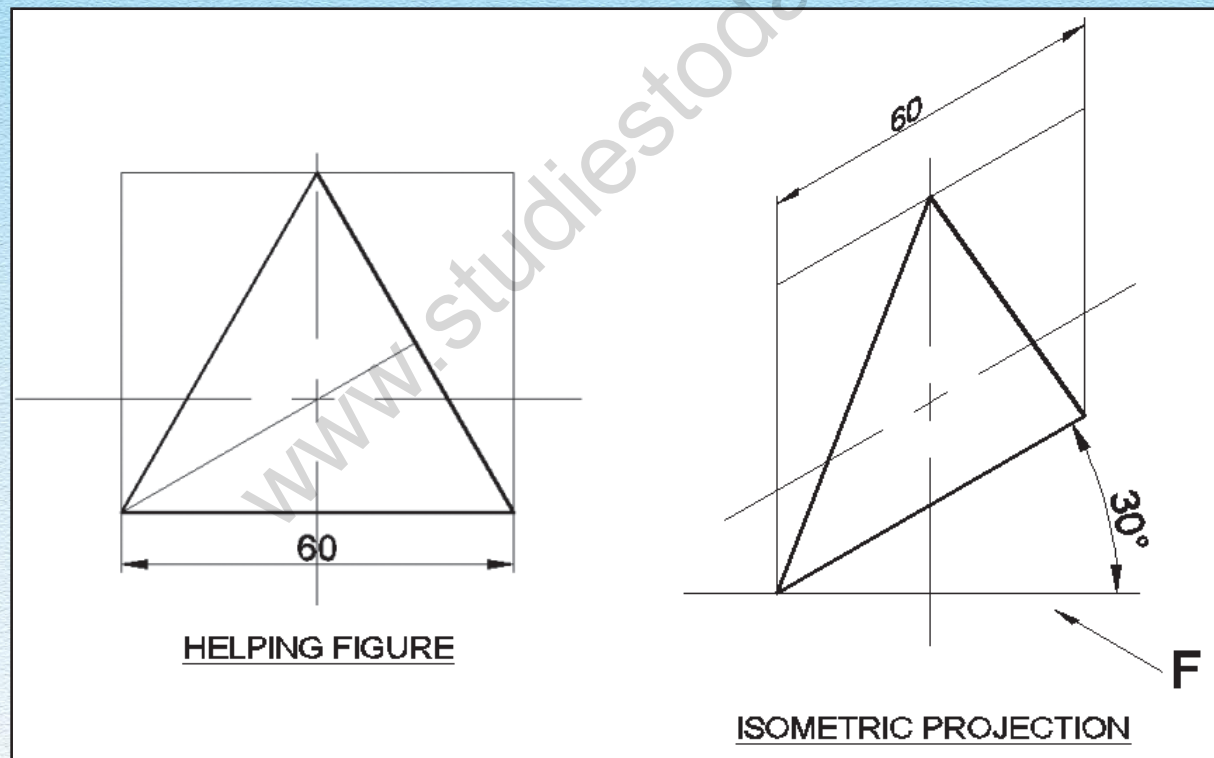


Fig. 7.13

Steps :

- (i) Draw a regular triangle of 60 mm isometric length and mark its centre.
- (ii) Enclose it in a box and transfer points onto the box lines to complete the helping Fig..
- (iii) Draw two principal axes along 30° and 90° lines in V.P.
- (iv) Copy the dimensions of box on isometric projection and complete it.
- (v) Copy all the points of helping fig box on to the isometric box.
- (vi) Draw the visible lines, dimensioning and Direction of viewing (F).

Example 7.3 : Draw the isometric projection of a square lamina having side 50 mm and its surface parallel to H.P.

Solution : Refer to Fig. 7.14

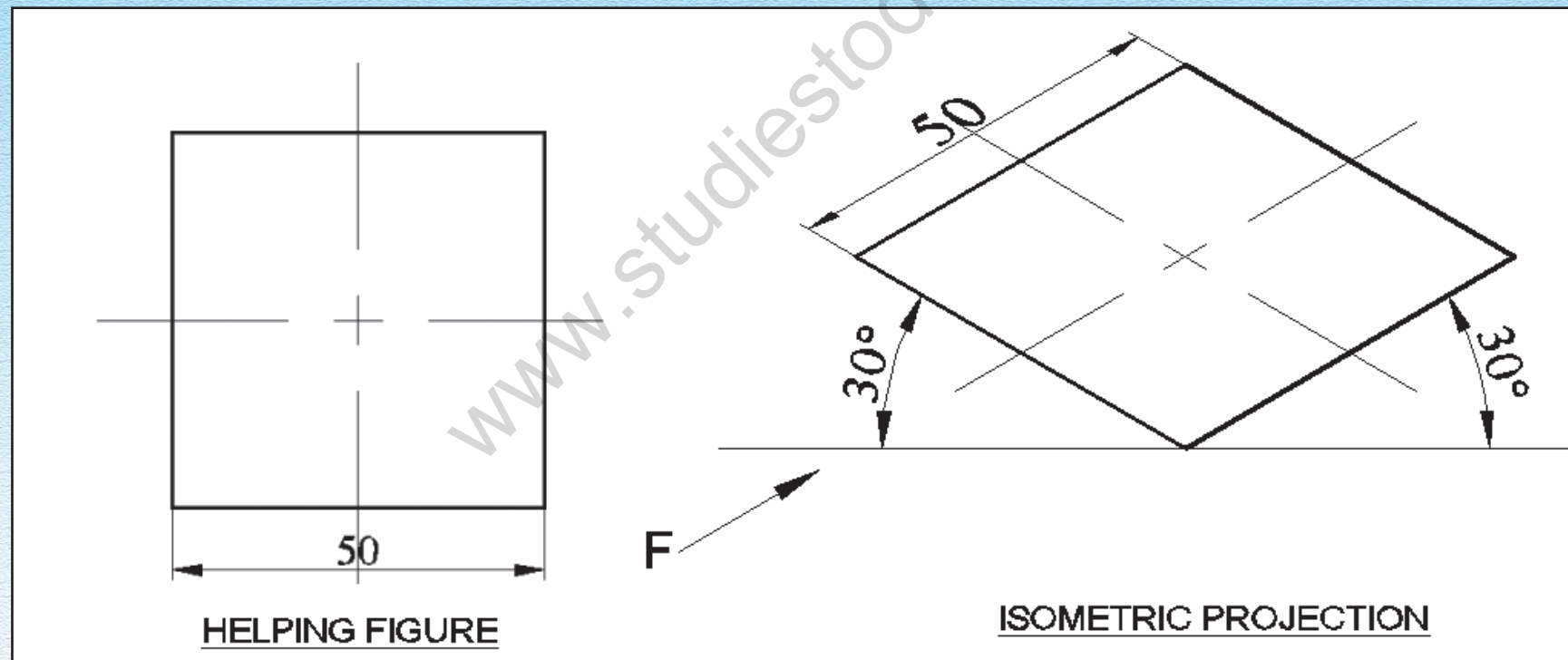


Fig. 7.14

Steps :

- (i) Draw the helping Fig. and its centre with isometric length.
- (ii) Transfer the points to the principal axes along 30° to 30° to keep it in H.P. and complete it.

Example 7.4 : Draw the isometric projection of a square laminae having side 40 mm and kept in V.P.

Solution : Refer to Fig. 7.15

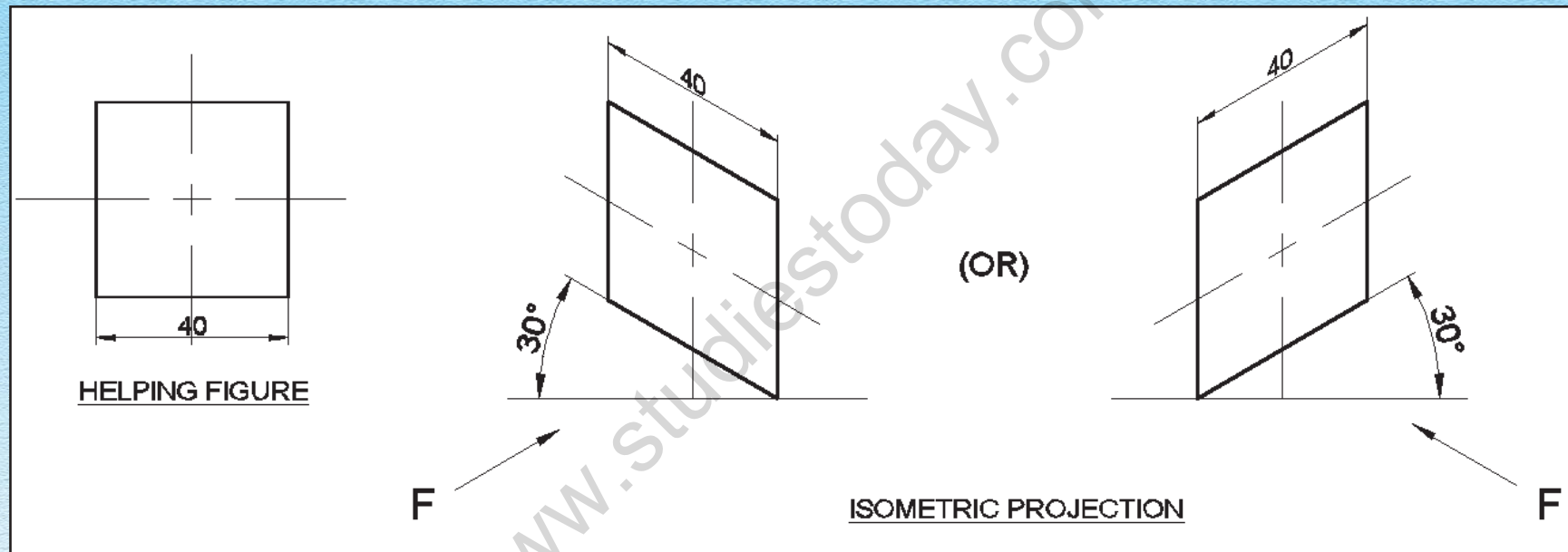


Fig. 7.15

Steps :

- (i) Draw the helping Fig. and its centre by isometric scale.
- (ii) Transfer the points to the principal axes along 30° to 90° to keep it in V.P. and complete it.

Example 7.5 : Draw the isometric projection of a regular pentagon of base side 40 mm in V.P.

Solution : Refer to Fig. 7.16

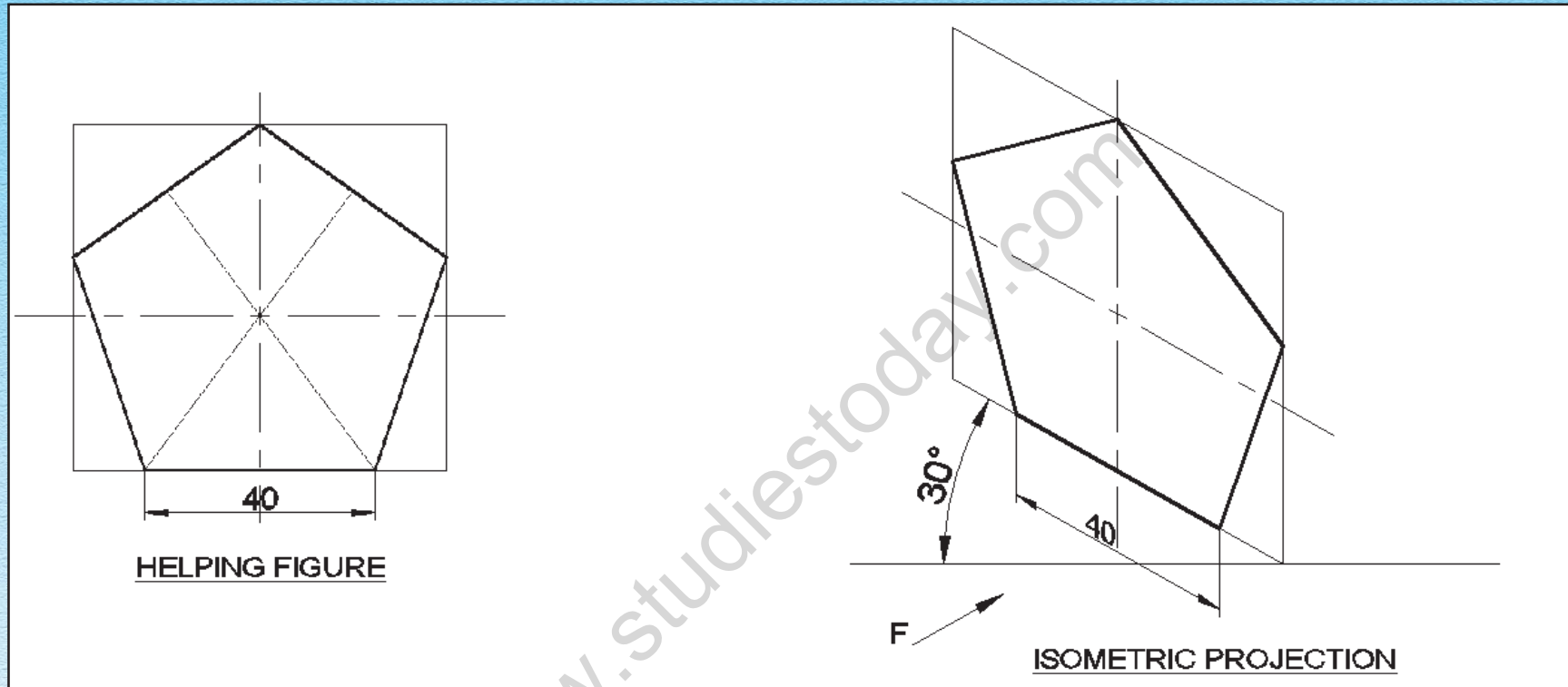


Fig. 7.16

Steps :

- (i) Draw a regular pentagon of 40 mm isometric length and mark its centre.
- (ii) Enclose it in a box and transfer points onto the box lines to complete the helping Fig..
- (iii) Draw two principal axes along 30° and 90° lines.
- (iv) Copy the dimensions of box and transfer all the points.
- (v) Draw the visible lines, dimensioning and Direction of viewing (F).

Example 7.6 : Draw the isometric projection of a regular pentagon of base side 40 mm in H.P.

Solution : Refer to Fig. 7.17

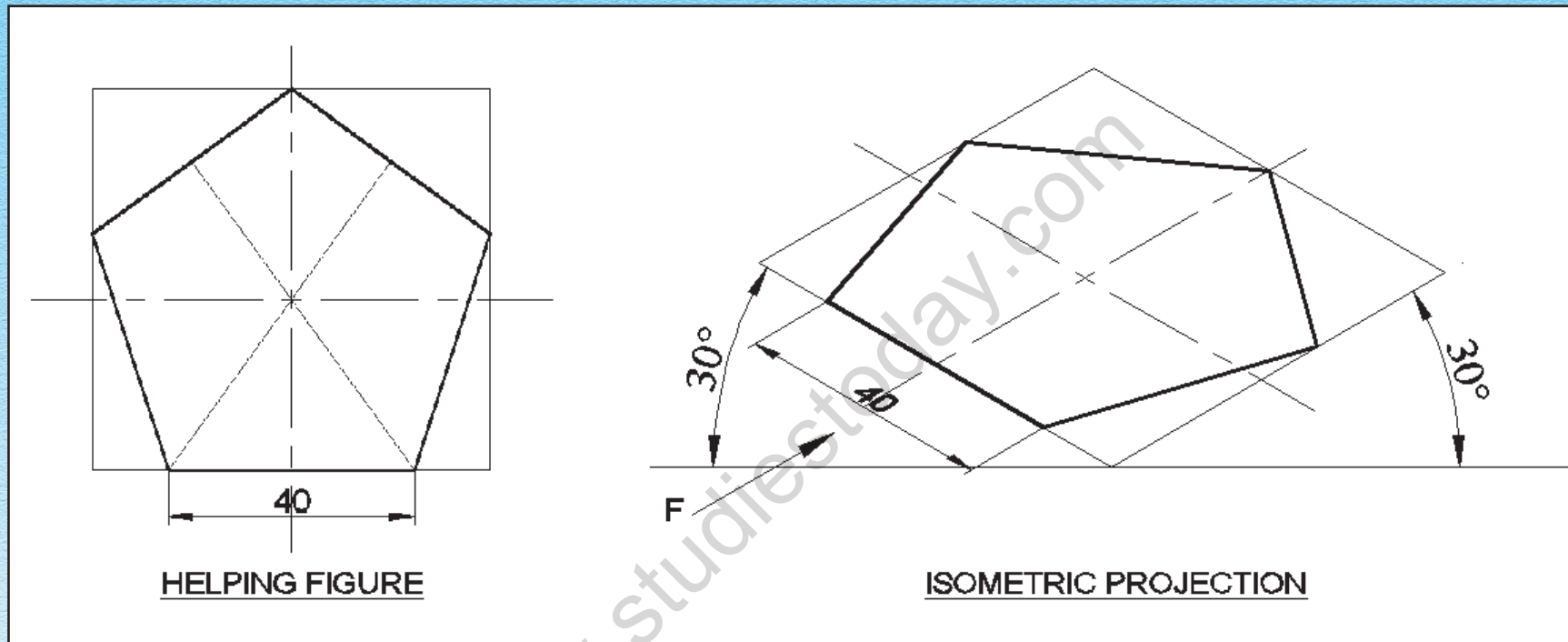


Fig. 7.17

Steps :

- (i) Draw a regular pentagon of 40 mm isometric length and mark its centre.
- (ii) Enclose it in a box and transfer points onto the box lines to complete the helping Fig..
- (iii) Draw two principal axes along 30° and 30° lines.
- (iv) Copy the dimensions of box and transfer all the points.
- (v) Draw the visible lines, dimensioning and Direction of viewing (F).

Example 7.7 : Draw the isometric projection of a regular hexagon of base side 30 mm in V.P. keeping two of its bases parallel to H.P.

Solution : Refer to Fig. 7.18

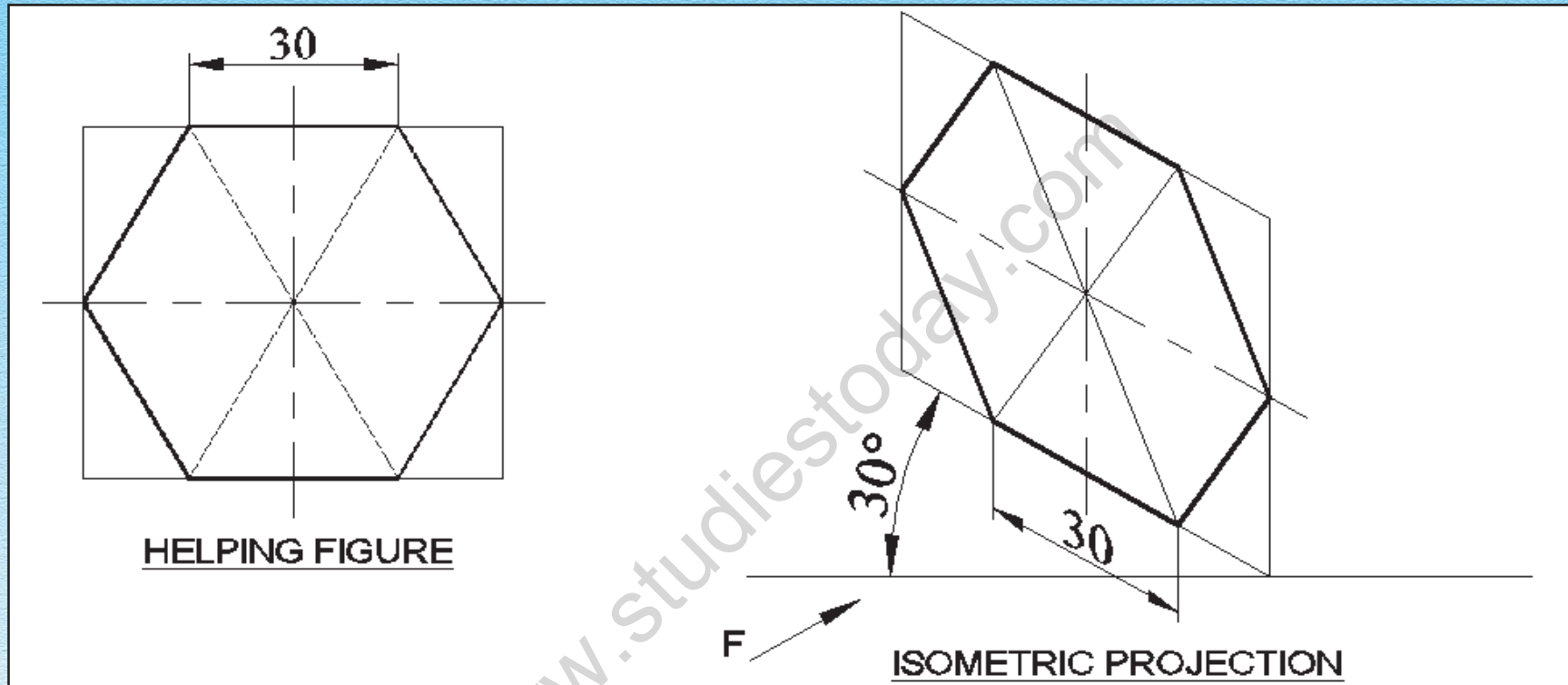


Fig. 7.18

Steps :

- (i) Draw a regular hexagon of 30 mm isometric length and mark its centre.
- (ii) Enclose it in a box and transfer points onto the box lines to complete the helping Fig..
- (iii) Draw two principal axes along 30° and 90° lines.
- (iv) Copy the dimensions of box keeping box dimension of one base line along 30° line and transfer all the points.
- (v) Draw the visible lines, dimensioning and Direction of viewing (F).

Example 7.8 : Draw the isometric projection of a regular hexagon of base side 25 mm in H.P. keeping two of its bases perpendicular to the V.P.

Solution : Refer to Fig. 7.19

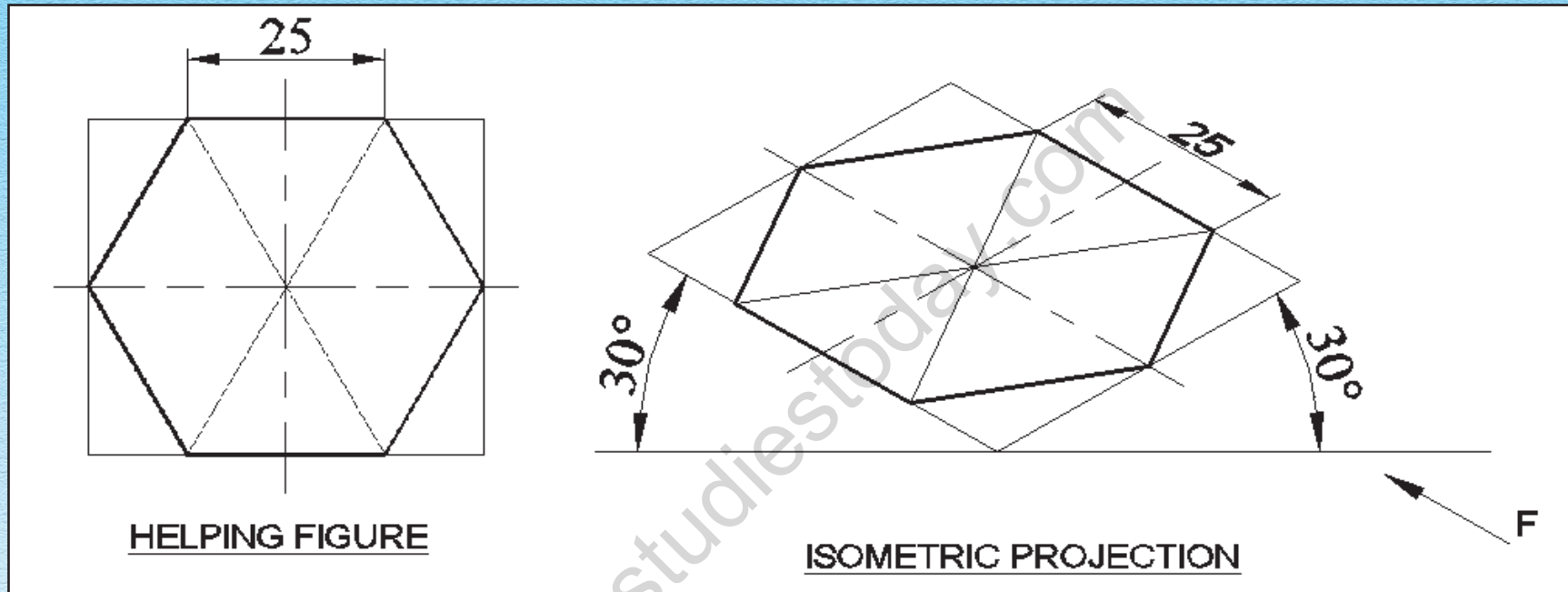


Fig. 7.19

Steps :

- (i) Draw a regular hexagon of 25 mm isometric length and mark its centre.
- (ii) Enclose it in a box and transfer points onto the box lines to complete the helping Fig..
- (iii) Draw two principal axes along 30° and 30° lines.
- (iv) Copy the dimensions of box, keeping box dimension of one base line along 30° line, which is perpendicular to the direction of viewing and transfer all the points.
- (v) Draw the visible lines, dimensioning and direction of viewing (F).

Example 7.9 : Draw the isometric projection of a circle of dia 40 mm in V.P.

Solution : We know that circle does not have any corner point and for the reference we always use centre lines with it. So circle is drawn in three different methods in isometric projection as follows :

Method A : Refer to Fig. 7.20

The true projection of circle is drawn by this method. It is called **offset method**.

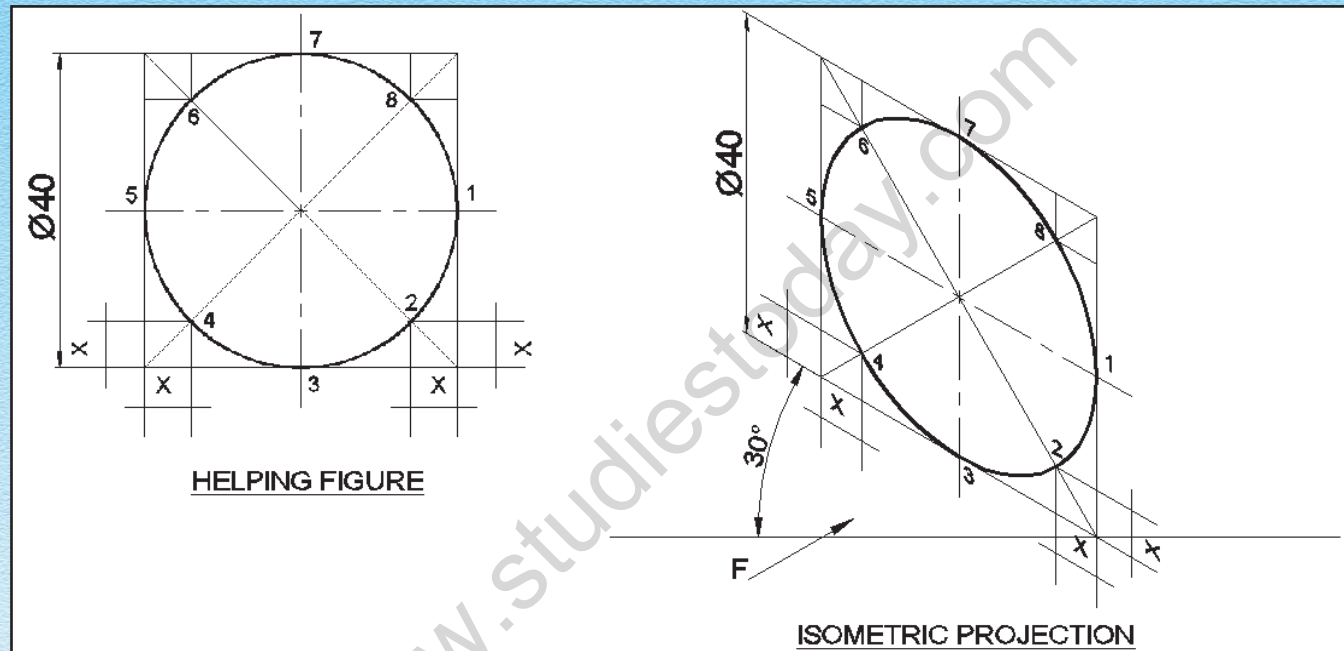


Fig. 7.20

Steps :

- (i) Draw a circle of 40 mm dia isometric length and mark its centre.
- (ii) Enclose it in a box, as the circle has dia, so is square.
- (iii) Draw the diagonals of square.
- (iv) Mark all the intercepts of circle with centre lines and diagonals as 1 to 8.
- (v) Draw two principal axes along 30° and 90° lines.
- (vi) Transfer all the offsets and dimensions of helping Fig. box to these principal axes.
- (vii) Join all the points 1 to 8 by a smooth curve.
- (viii) Complete the dimensioning and Direction of viewing (F).

Method B : Refer to Fig. 7.21

In this method, we divide the circle in 12 equal parts. It is called **coordinate construction method**.

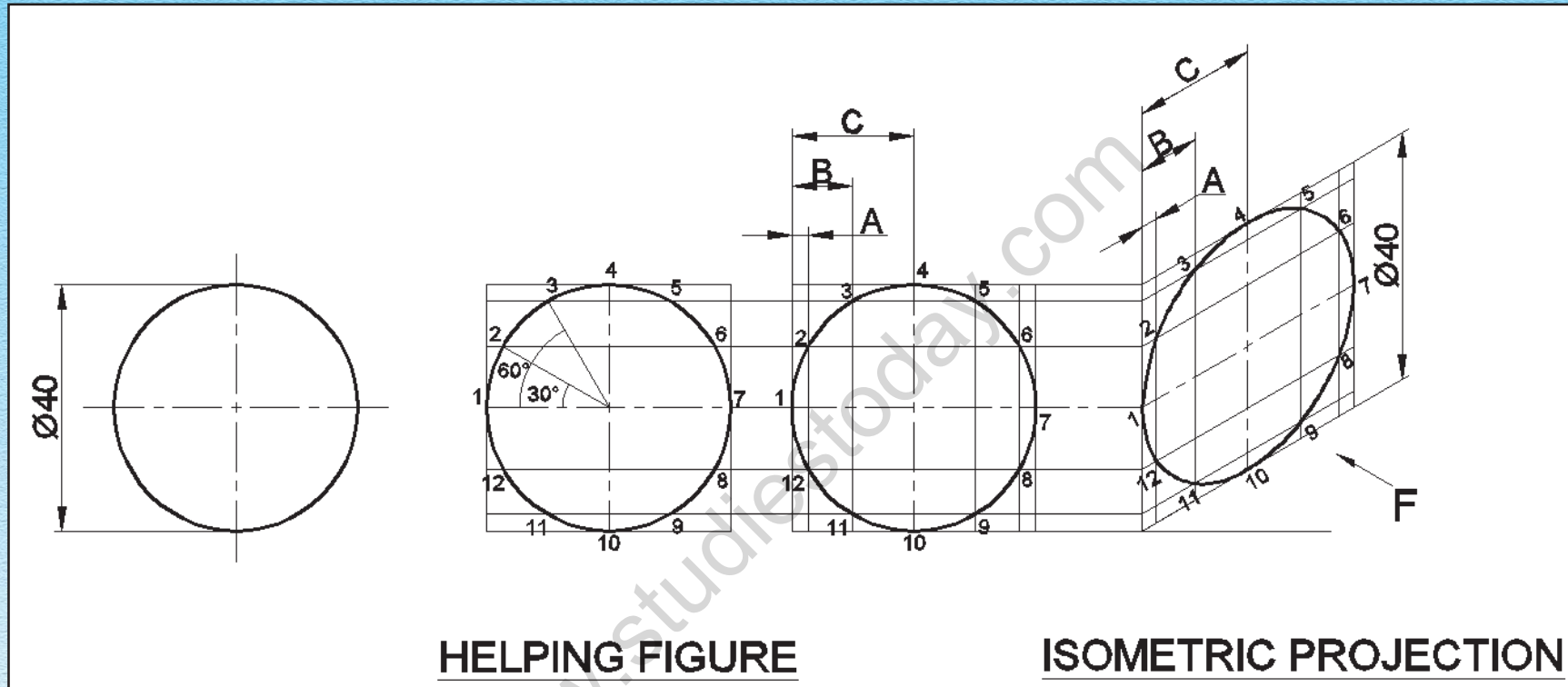


Fig. 7.21

Steps :

- (i) Draw a circle of 40 mm dia isometric length and mark its centre.
- (ii) Enclose it in a box. Draw the intercepts at 30° & 60° and mark all the intercepts as 1 to 12.
- (iii) Draw two principal axes along 30° and 90° lines.
- (iv) Transfer the coordinates of 1 to 12 points and then join all the points marked at principal axes by a smooth curve.
- (v) Complete the dimensioning and direction of viewing (F).

Method C : Refer to Fig. 7.22

The true projection of circle is time consuming. So we can use **Four centre method** for Drawing an approximate projection of circle. This method is frequently used.

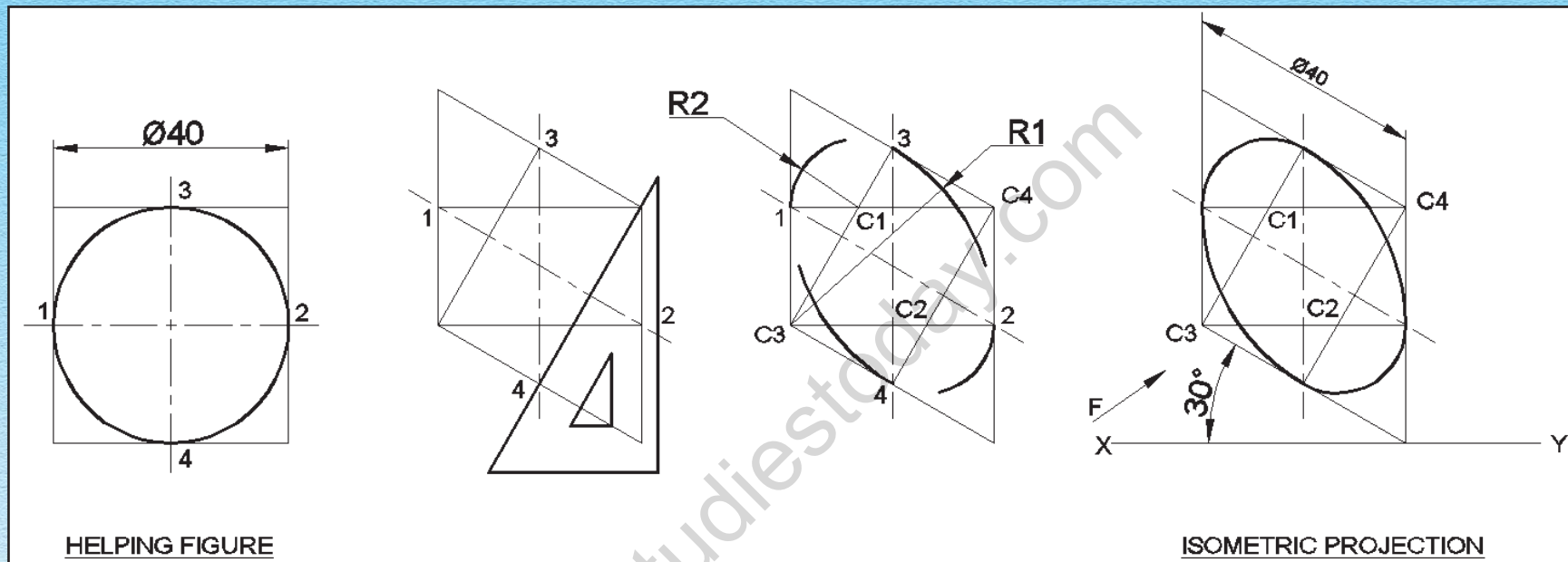


Fig. 7.22

Steps :

- (i) Draw a circle of 40 mm dia isometric length and mark its centre.
- (ii) Enclose it in a box, as the circle has dia, so box is square i.e. helping Fig..
- (iii) Draw two principle axes along 30° and 90° lines.
- (iv) Copy the dimensions of helping Fig. to isometric box.
- (v) Use a 30° - 60° set square to locate points 1, 2, 3 and 4 (or) join the ends of smaller diagonals to the midpoints of opposite sides.
- (vi) Take C_1, C_2 as centres and a radius equal to C_11 , draw arcs as shown.
- (vii) Take C_3, C_4 as centres and a radius equal to C_33 . draw arcs as shown.
- (viii) Complete the dimensioning and direction of viewing (F).

Example 7.10 : Draw the isometric projection of a circle of dia 40 mm in H.P.

Solution : Refer to Fig. 7.23

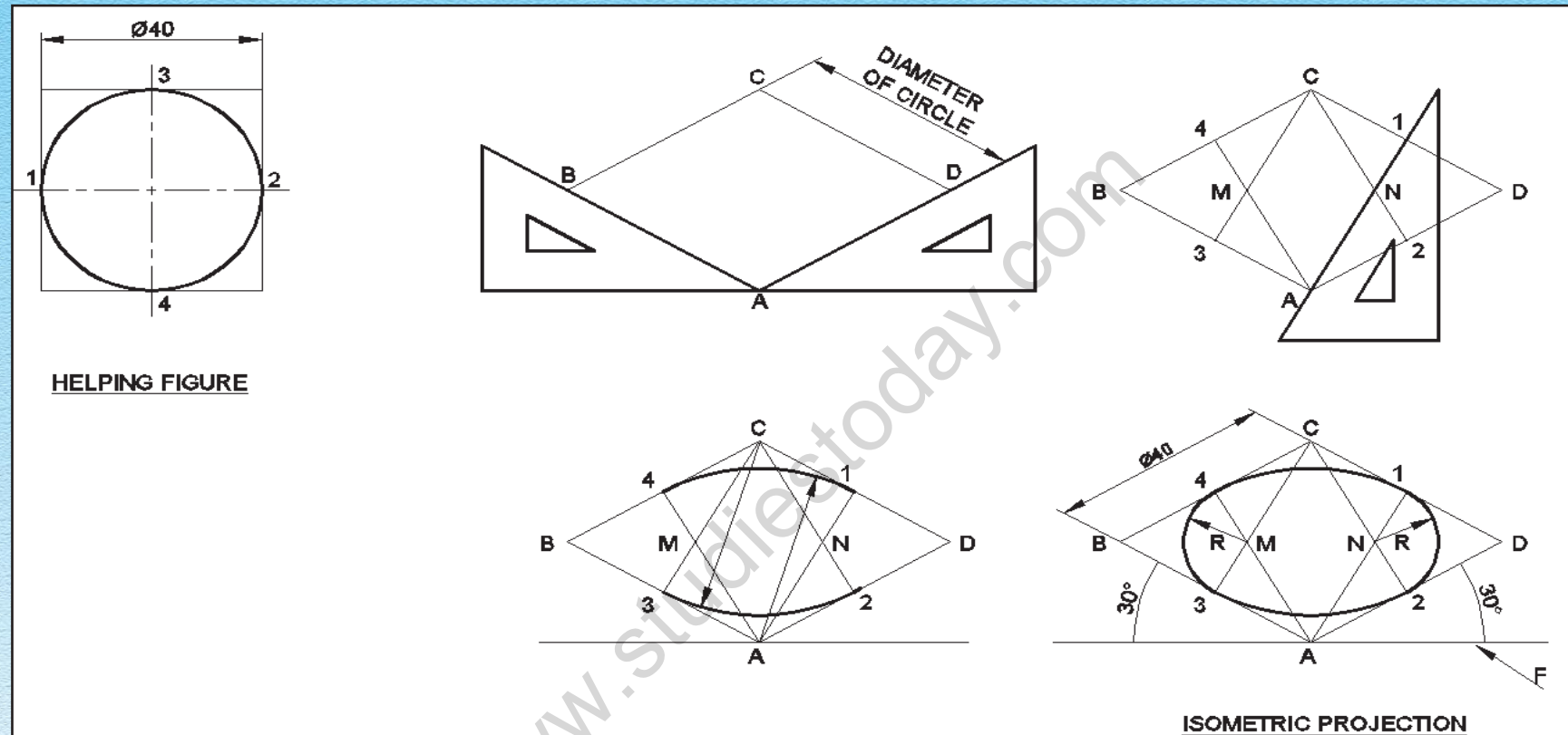


Fig. 7.23

Steps :

- (i) Draw a circle of dia 40 mm isometric length and mark its centre.
- (ii) Enclose it in a box, as the circle has dia, so box is a square, helping Fig..
- (iii) Draw two principle axes along 30° and 30° lines with the help of $30^\circ - 60^\circ$ set square.
- (iv) Complete the rhombus and name it.
- (v) Use a $30^\circ - 60^\circ$ set square to locate points M and N from points A and C.
- (vi) Take A and C as centres and radius equal to A1 draw arcs as shown.
- (vii) Take M and N as centres and radius equal to M4, draw arcs as shown.
- (viii) Complete the dimensioning and direction of viewing (F)

Example 7.11 : Draw the isometric projection of a semicircle of dia 50 mm in V.P. (a) resting on its curved edge. (b) resting on its diameter.

(a) Solution : Refer to Fig. 7.24

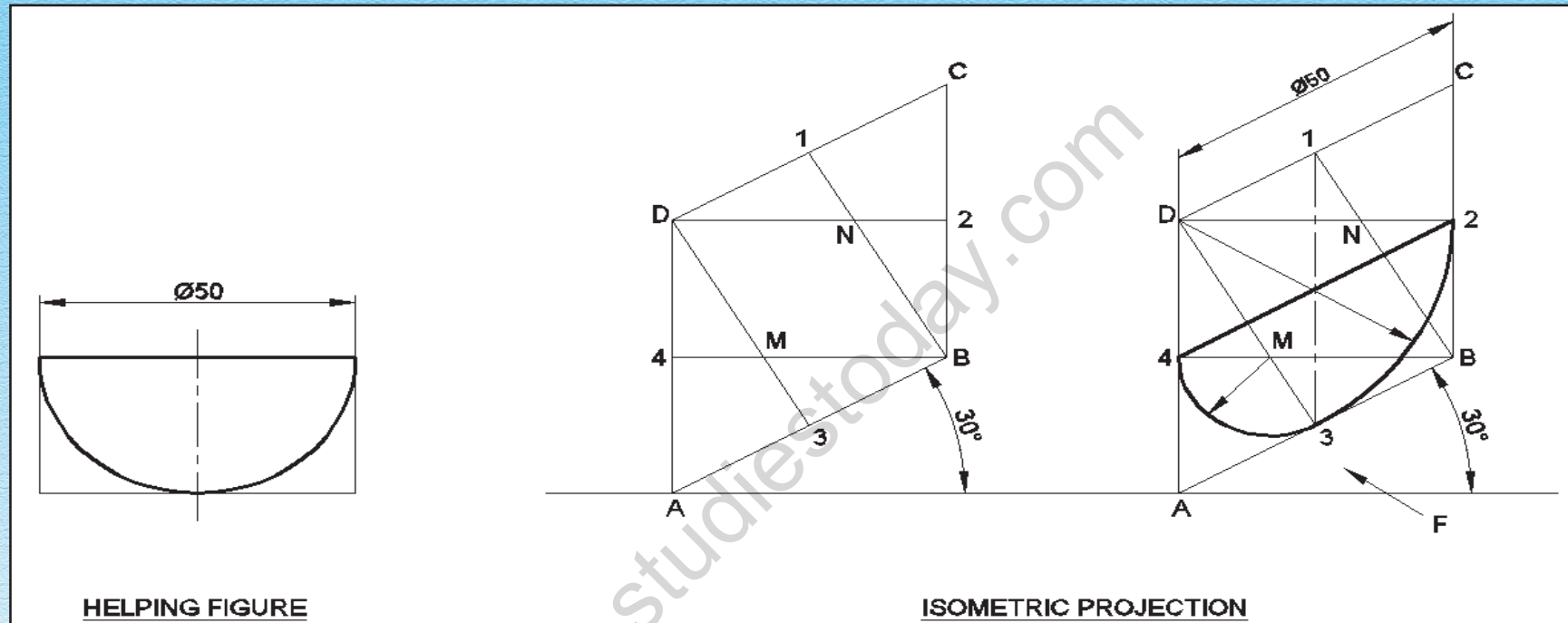


Fig. 7.24

Steps :

- (i) Draw a semi circle of dia 50 mm isometric length and mark its centre.
- (ii) Enclose it in a box, as the circle has dia, so box is a square i.e. helping Fig..
- (iii) Draw two principle axes along 30° and 90° lines with the help of set square.
- (iv) Complete the rhombus and name it.
- (v) Use a $30^\circ - 60^\circ$ set square to locate points M and N from points B and D.
- (vi) Take M as centre and M 3 as radius, draw arc as shown.
- (vii) Take D as centre and D3 as radius, draw arc as shown.
- (viii) Join 2 to 4 to complete the semi-circle.
- (ix) Complete the dimensioning and direction of viewing (F).

(b) **Solution :** Refer to Fig. 7.25

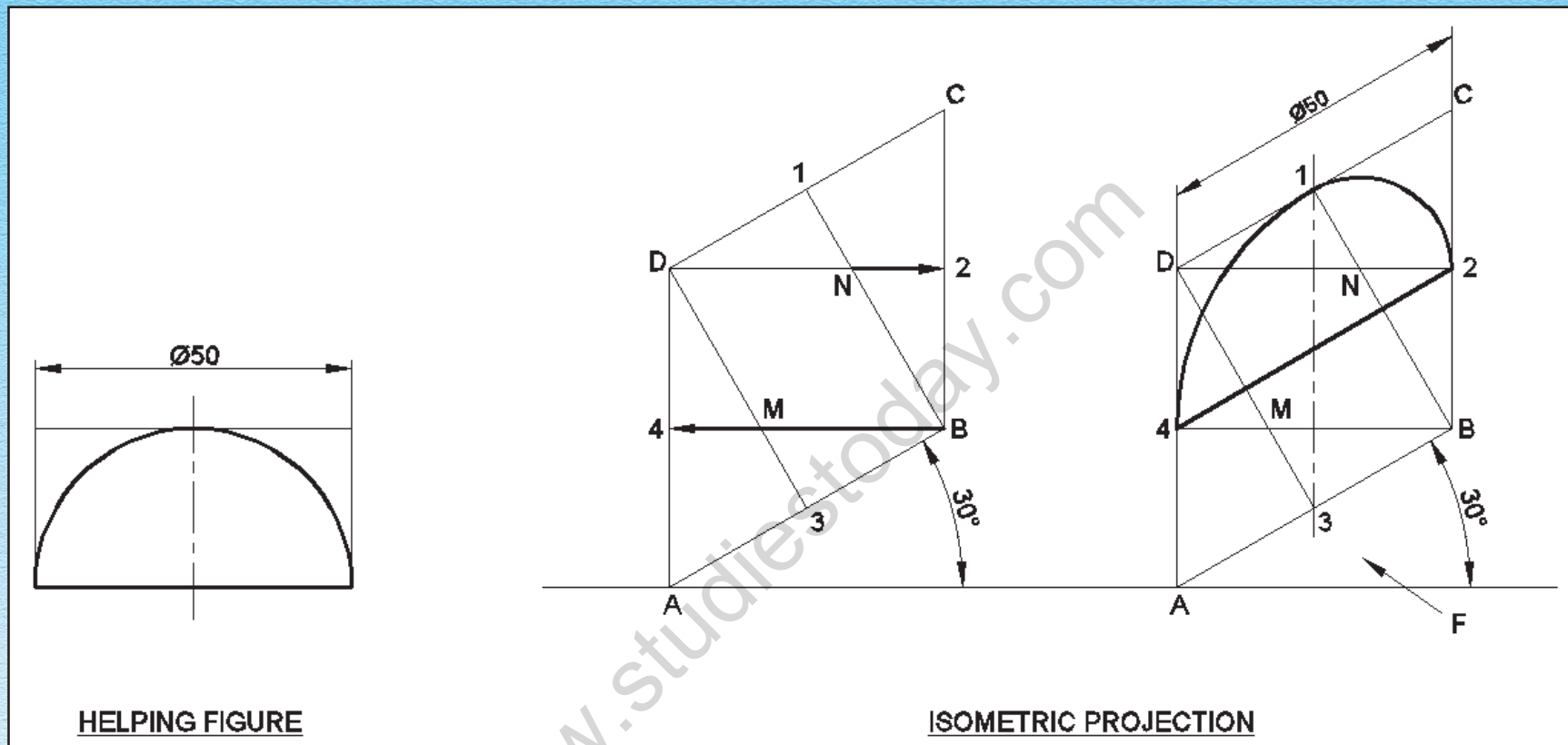


Fig. 7.25

Steps :

- (i) to (v) are same as discussed in (a)
- (vi) Take N as centre and N 2 as radius, draw arc as shown.
- (vii) Take B as center and B4 as radius, draw arc as shown.
- (viii) Join 2 to 4 to complete the semi-circle in isometric projection.
- (ix) Complete the dimensioning and direction of viewing (F).

DO YOU KNOW ?**ISOMETRIC DRAWING (Isometric View)**

As the name implies, in isometric drawing, all object edges are drawn with true length scale instead of foreshortened, isometric length scale. Due to the true length isometric drawing is slightly larger (22.5%) than the isometric projection. It is customary to draw isometric drawing rather than isometric projection, because it is much easier to draw, satisfactory to understand and a layman can directly measure the dimensions from the three principal axes of the drawing itself.

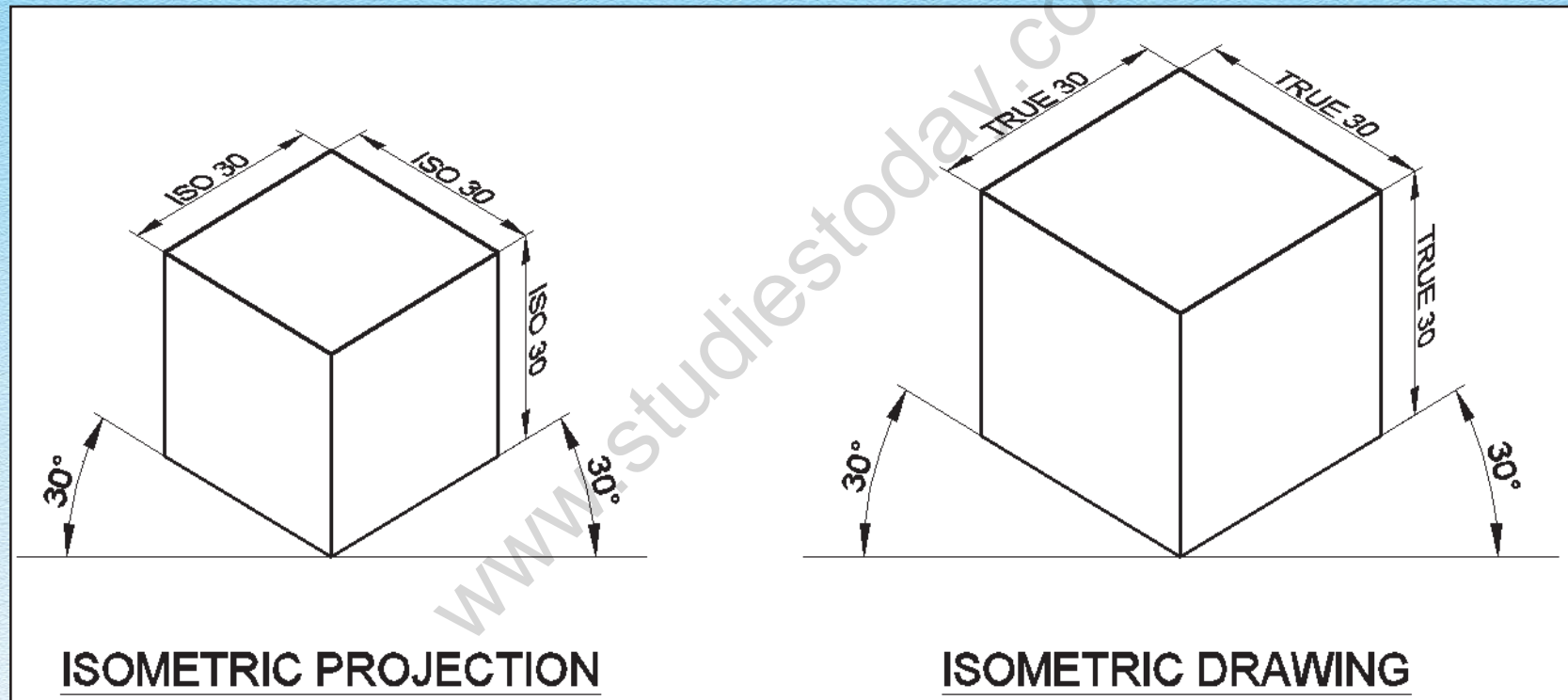


Fig. 7.26

WHAT WE HAVE LEARNT

We have learnt to show the details of an object in an easy and understandable way. Isometric projection gives the most perfect idea of the object. Layman can also copy the dimensions of object from its isometric drawing.

ASSIGNMENT

1. Draw the isometric projection of an equilateral triangle of base side 50 mm in V.P.
2. Draw the isometric projection of a square lamina having side 55 mm in H.P.
3. Draw the isometric projection of a regular pentagon of base side 35 mm in V.P.
4. Draw the isometric projection of a regular hexagon of base side 30 mm in H.P.
5. Draw the isometric projection of a circle of dia 50 mm in H.P.
6. Draw the isometric projection of a semi-circle of radius 30 mm in H.P.