ME 101

ENGINEERING GRAPHICS

CHAPTER 5
ISOMETRIC DRAWING

Introduction and Objectives

❑ This lecture introduces the concept of Isometric projection and Isometric drawing of an object.

❑ Followings will be highlighted to be able to explain the Isometric drawing:

- ✓ Axonometric projection
- ✓ Isometric projection
- ✓ Isometric drawing
- ✓ Isometric and non-isometric lines (Boxing and offset methods)
- ✓ Angles in isometric drawing
- ✓ Curves in isometric drawing
- ✓ Circles in isometric drawing (Four center ellipse)
- ✓ Isometric circle arcs

❑ Students are required to understand the fundamentals of isometric drawing and the technical and practical details while drawing of an object.

PICTORIAL DRAWING AND SKETCHING METHODS

1. Axonometric projection
   a) Trimetric (Three axis are unequally foreshortened)
   b) Dimetric (Two axis are equally foreshortened)
   c) Isometric (Three axis are equally foreshortened)

2. Oblique projection

3. Perspective projection

5.1. AXONOMETRIC PROJECTION

Axonometric projection is theoretically orthographic projection in which only one plane is used, the object being turned so that three faces shown in one view. There can be an infinite number of axonometric positions depending upon the angles through which the object is rotated, see (Fig.5.1)

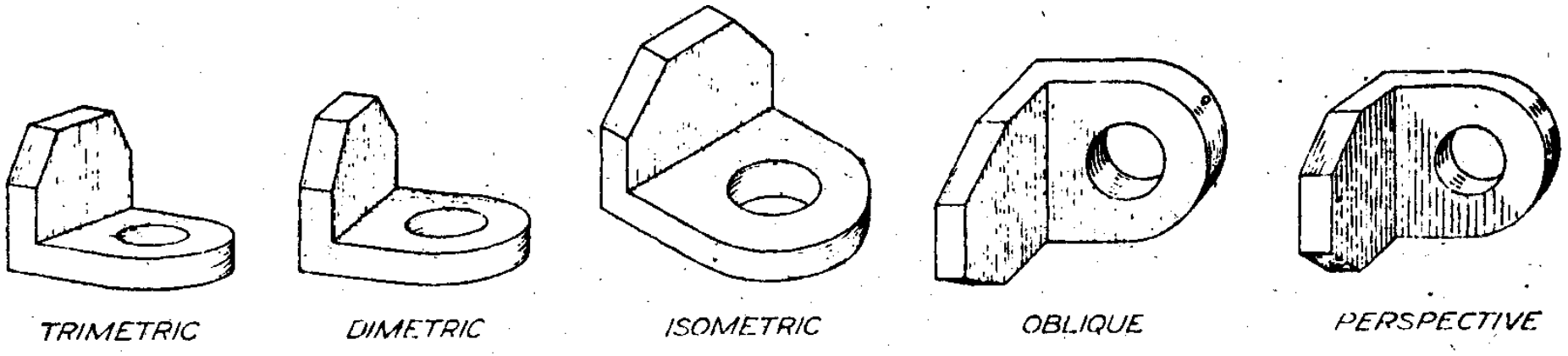


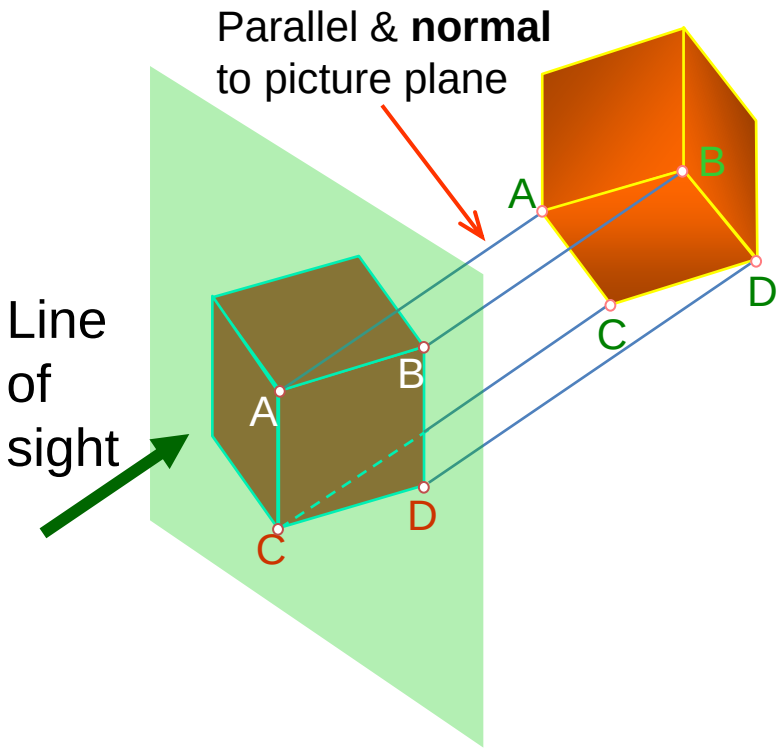
Fig. 5.1. Pictorial methods

The simplest is the isometric position in which three faces are foreshortened equally.

Axonometric Projection

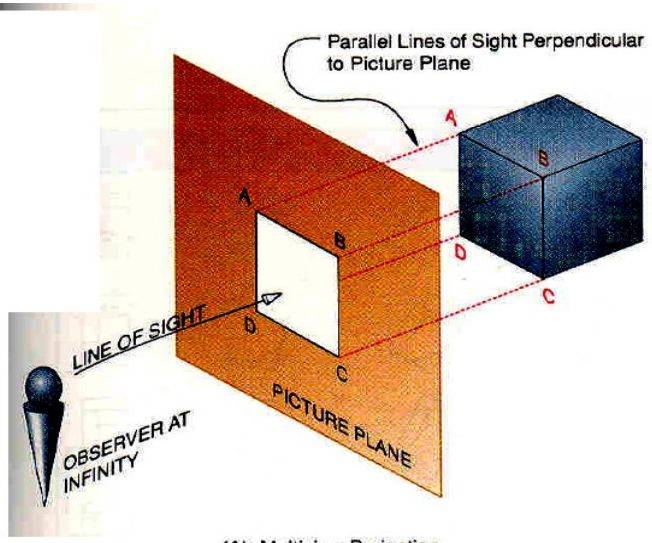
❑ It is a parallel projection technique used to create a pictorial drawing of an object by rotating the object on an axis relative a projection or picture plane.

❑ Axonometric projection is one of the four principal projection techniques: multiview, axonometric, oblique and perspective

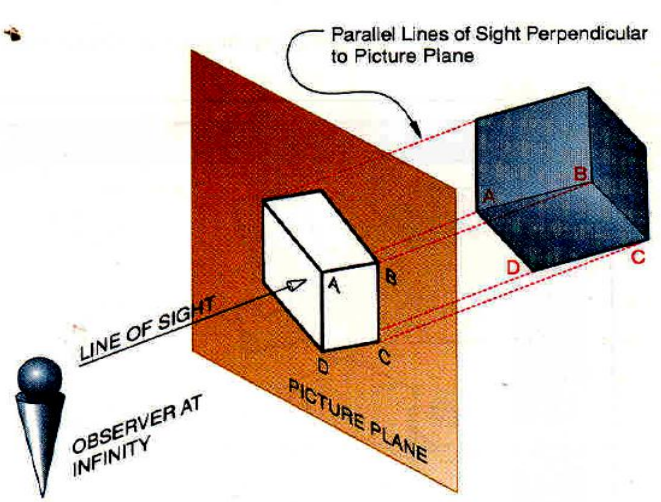


Axonometric Projection

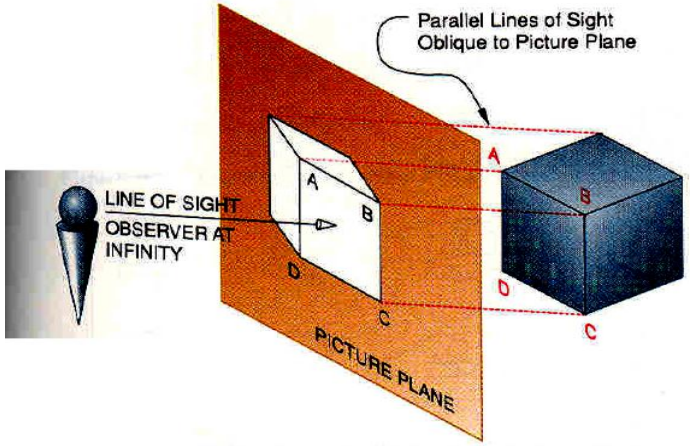
- In Multi views and axonometric projections, the lines of sight are perpendicular to the plane of projection; therefore, both are considered *orthographic projections*



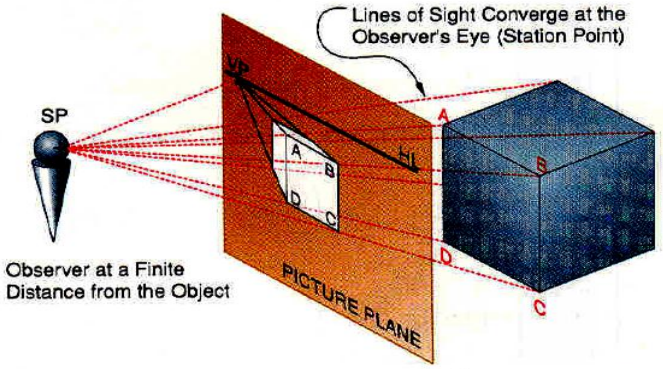
(A) Multiview Projection



(B) Axonometric Projection



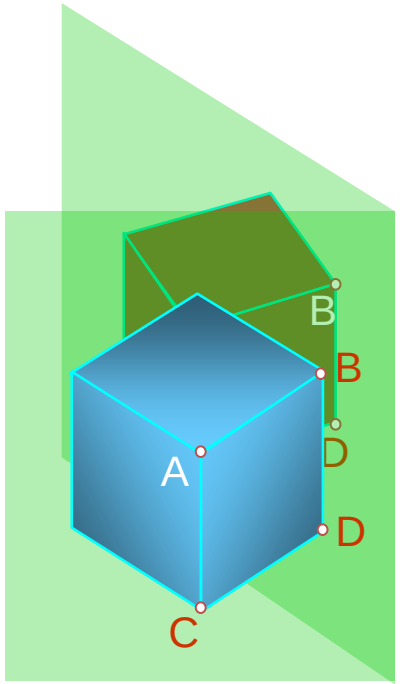
(C) Oblique Projection



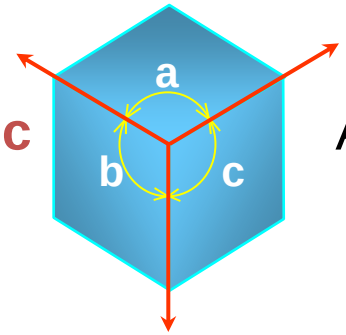
(D) Perspective Projection

Axonometric Projection

Type of axonometric drawing



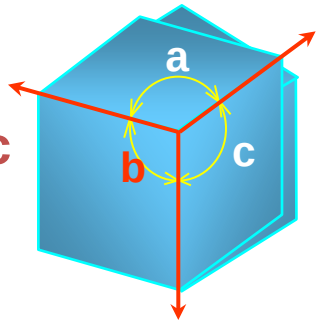
1. Isometric



Axonometric axis

All angles are equal.

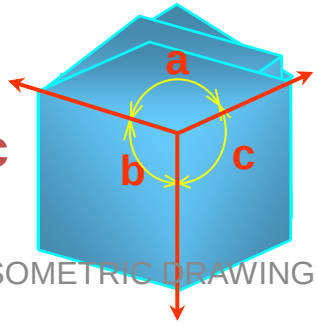
2. Dimetric



Axonometric axis

Two angles are equal.

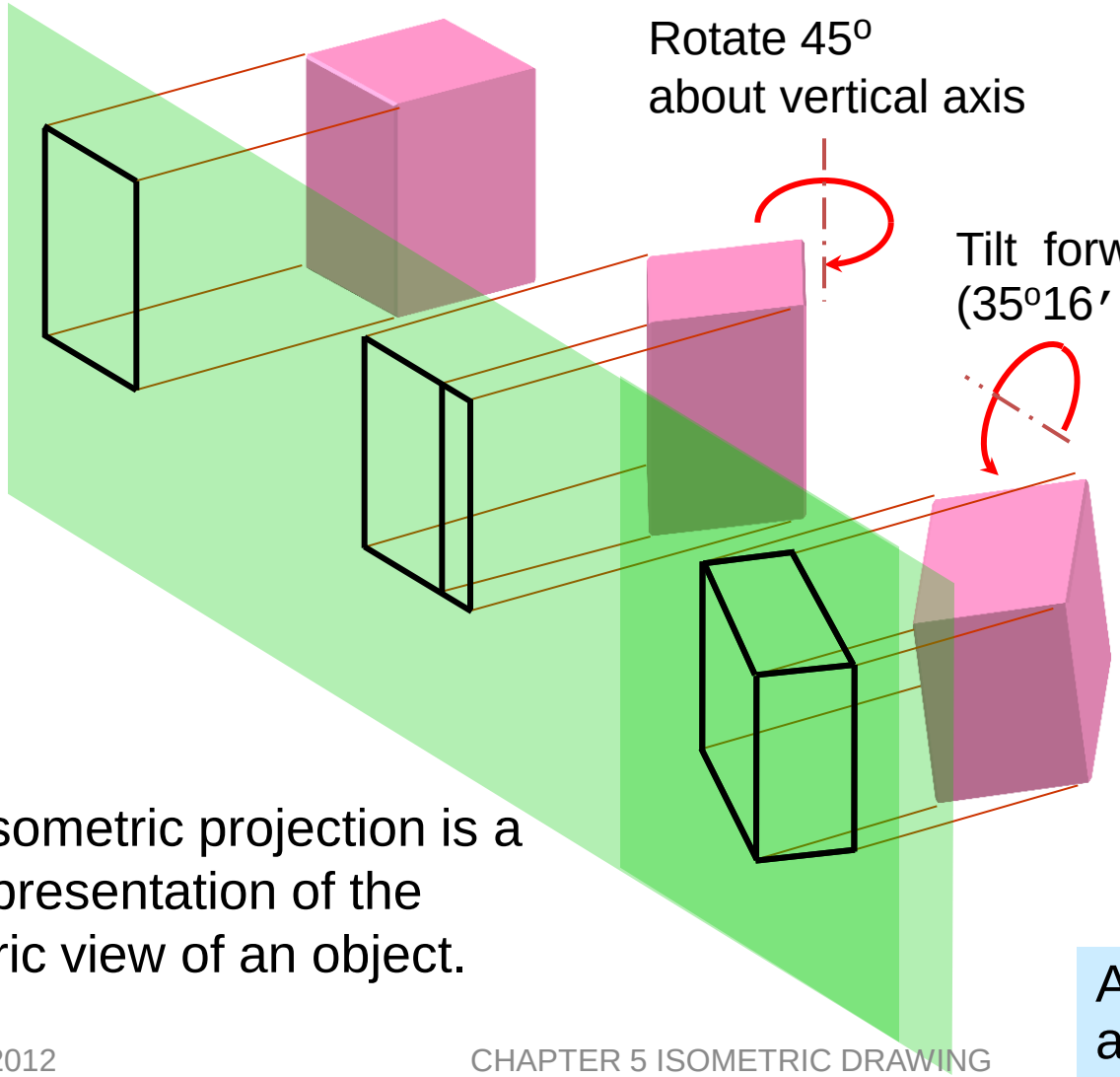
3. Trimetric



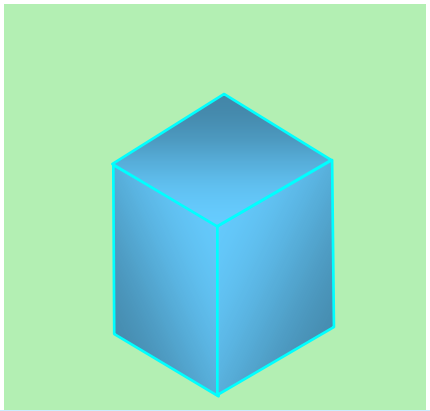
Axonometric axis

None of angles are equal.

Isometric Projection



❑ An isometric projection is a true representation of the isometric view of an object.

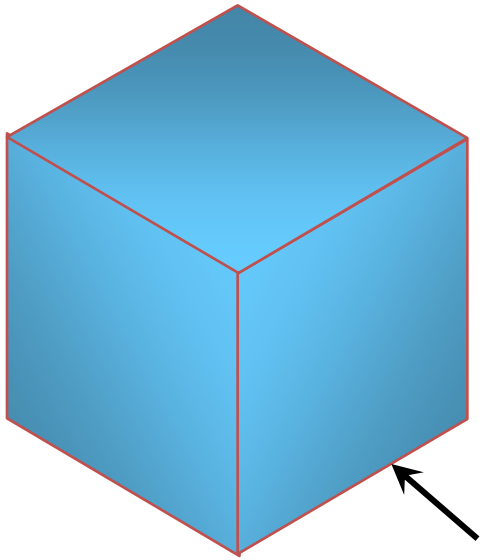


All edges ***foreshorten*** about 0.8 time.

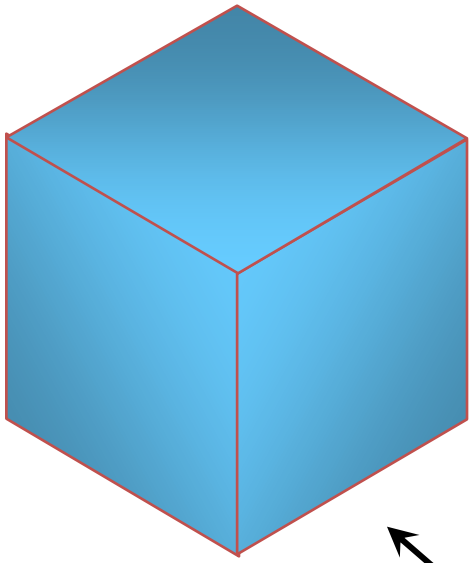
Isometric Drawing

- Isometric drawing is a drawing drawn on an isometric axes using ***full scale***.
- Isometric drawings are almost always preferred over isometric projection for engineering drawings, because they are easier to produce

Isometric projection
(True projection)

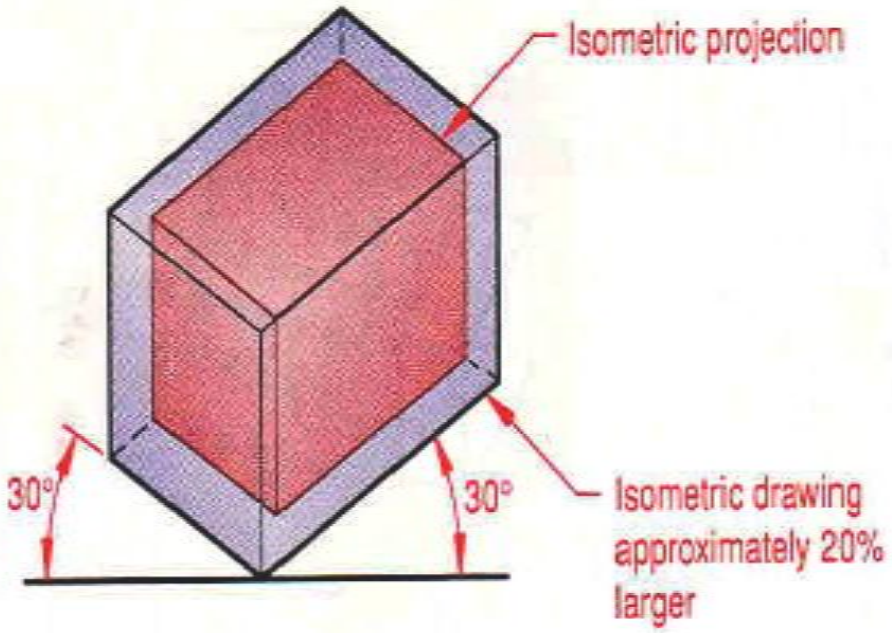


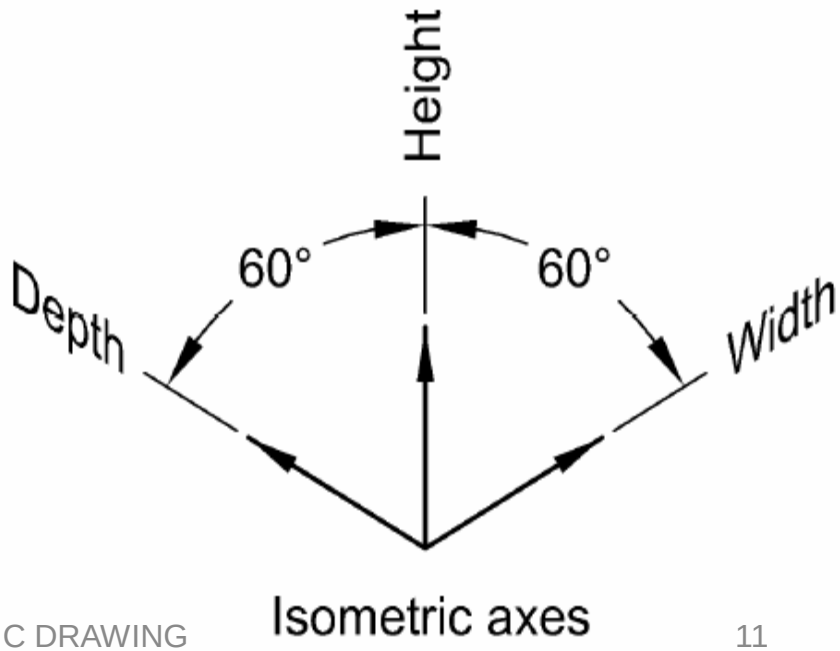
Isometric drawing
(Full scale)



Isometric Axes

❑ An *isometric drawing is an axonometric pictorial drawing for* which the angle between each axis equals 120º and the scale used is full scale.

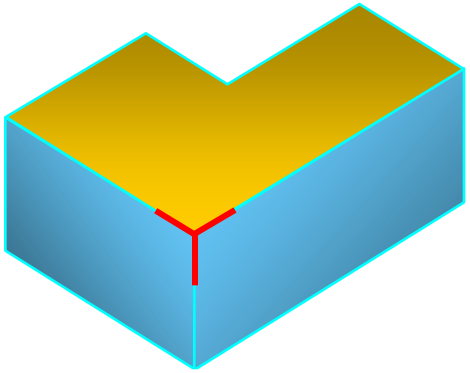




Positions of Isometric axes

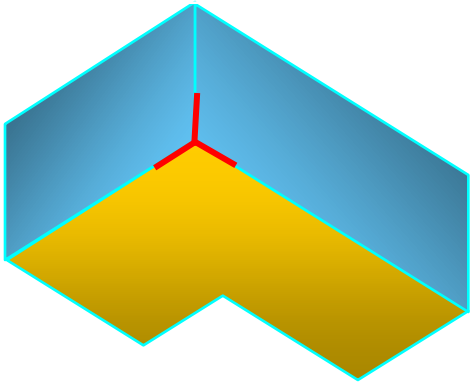
❑ Isometric axes can be arbitrarily positioned to create different views of a single object.

Regular isometric



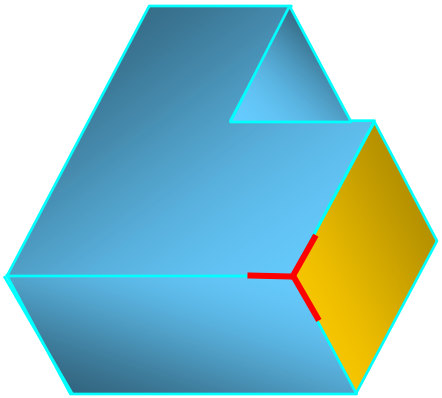
View point is looking down on the top of the object.

Reverse axis isometric



View point is looking up on the bottom of the object.

Long axis isometric



View point is looking from the right (or left) of the object.

5.2. ISOMETRIC PROJECTION

The cube in Fig.5.2 is rotated about a vertical axis through 45º, as shown at (B), and then tilted forwards at (C), until the edge RU is foreshortened equally with RS and RT.

The front view of the cube in this position is said to be an isometric projection (The cube has been tilted forward until the body diagonal through R is perpendicular to the front plane). The projections of the three mutually perpendicular edges RS, RT, and RU meeting at the point R make equal angles, 120º, with each other are called isometric axes.

Any line parallel to an edge of the cube, whose projection is thus parallel to an isometric axis is called an isometric line. The planes of the faces of the cube and all planes parallel to them are called isometric planes.

The isometric axes RS, RT and RU are all foreshortened equally because they are at the same angle to the picture plane.

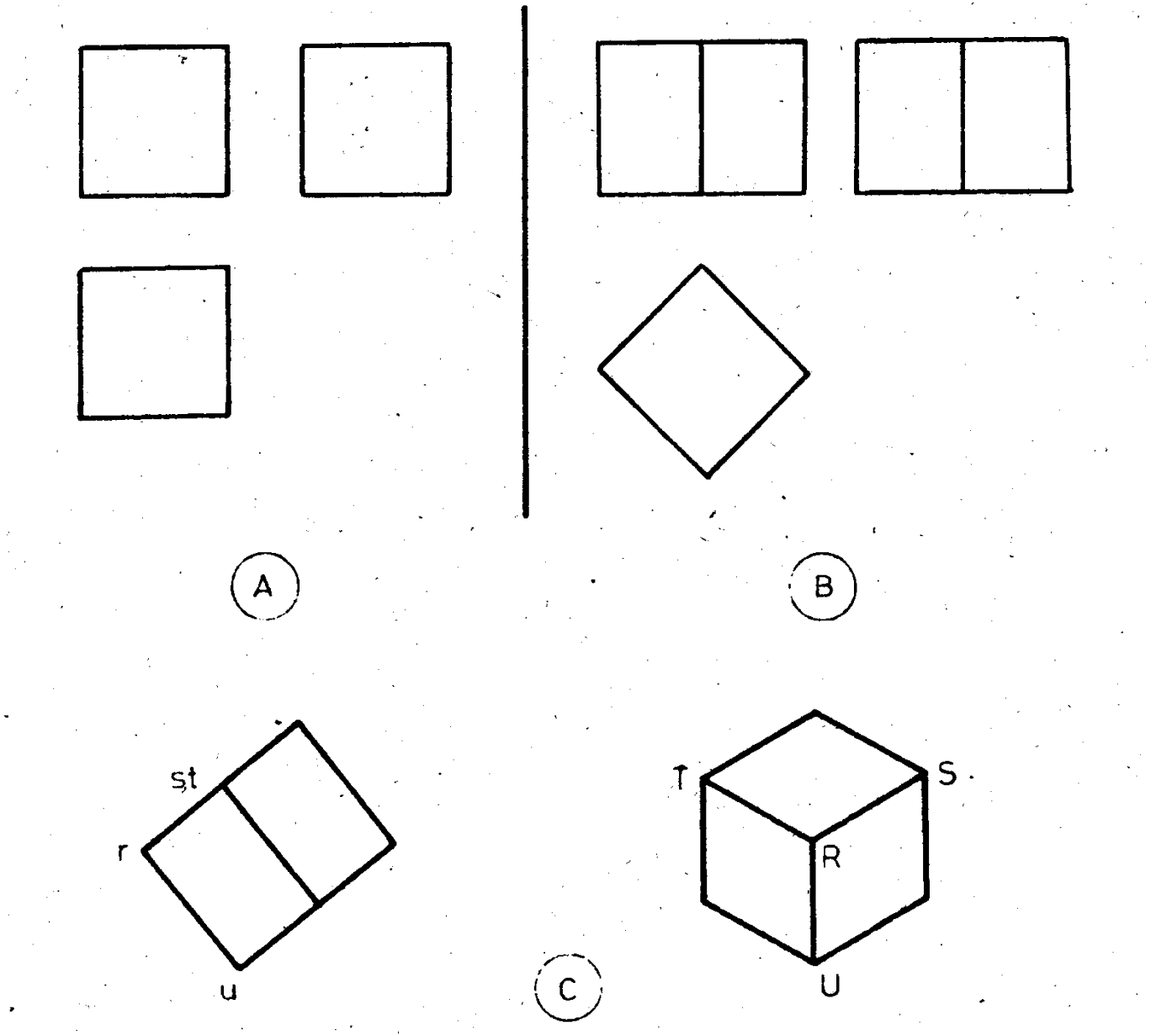


Fig. 5.2 The isometric cube. Rotated from position (A) to (B) then to (C), the three perpendicular edges are now equally foreshortened.

In isometric projection, the isometric lines have been foreshortened to approximately 81/100 of their length (Fig. 5.3) and an isometric scale to this proportion can be made graphically as shown in Fig. 5.4.

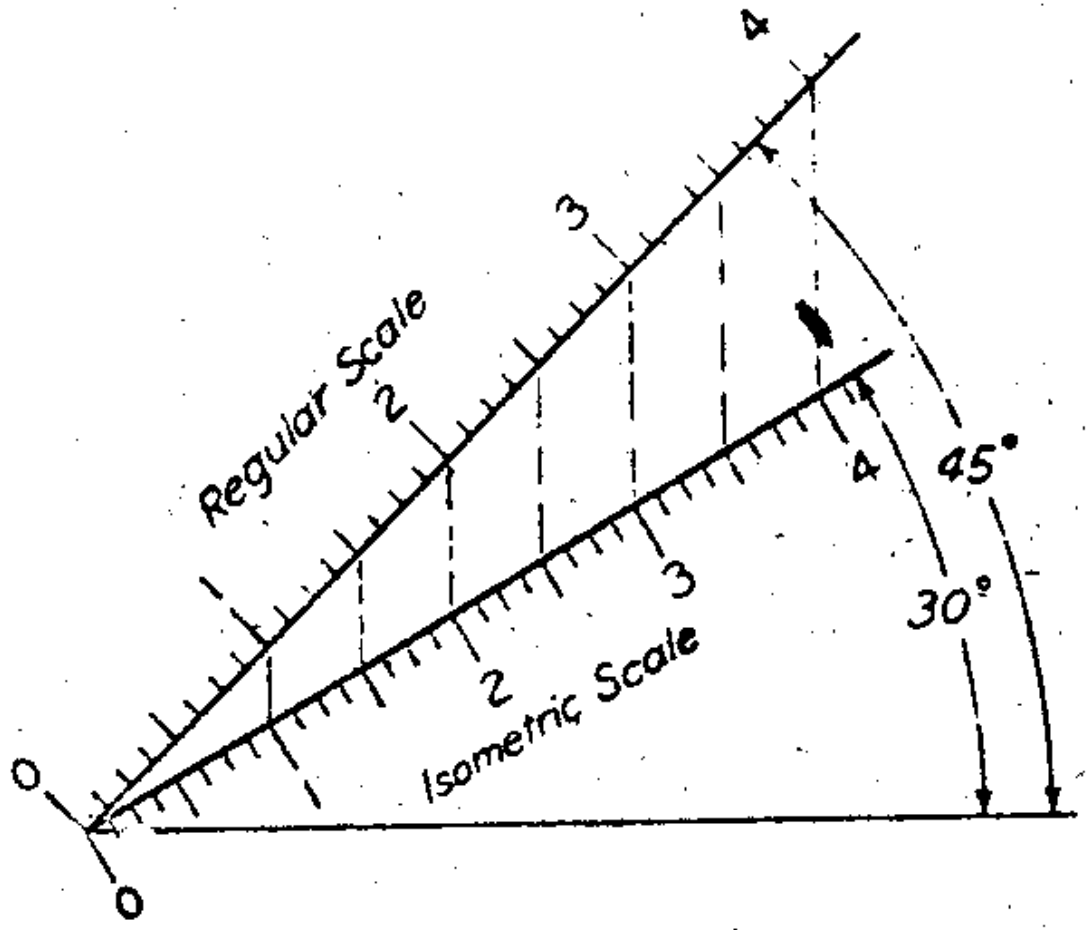


Fig. 5.4 To make an isometric scale.

5.3 ISOMETRIC DRAWING

On nearly all practical use of isometric system, the foreshortening of the lines are disregarded, and their full lengths are laid off on the axes. The effect of increased size is usually of no consequence, and since the advantage of measuring the lines directly is of great convenience, isometric drawing is used almost exclusively rather than isometric projection.

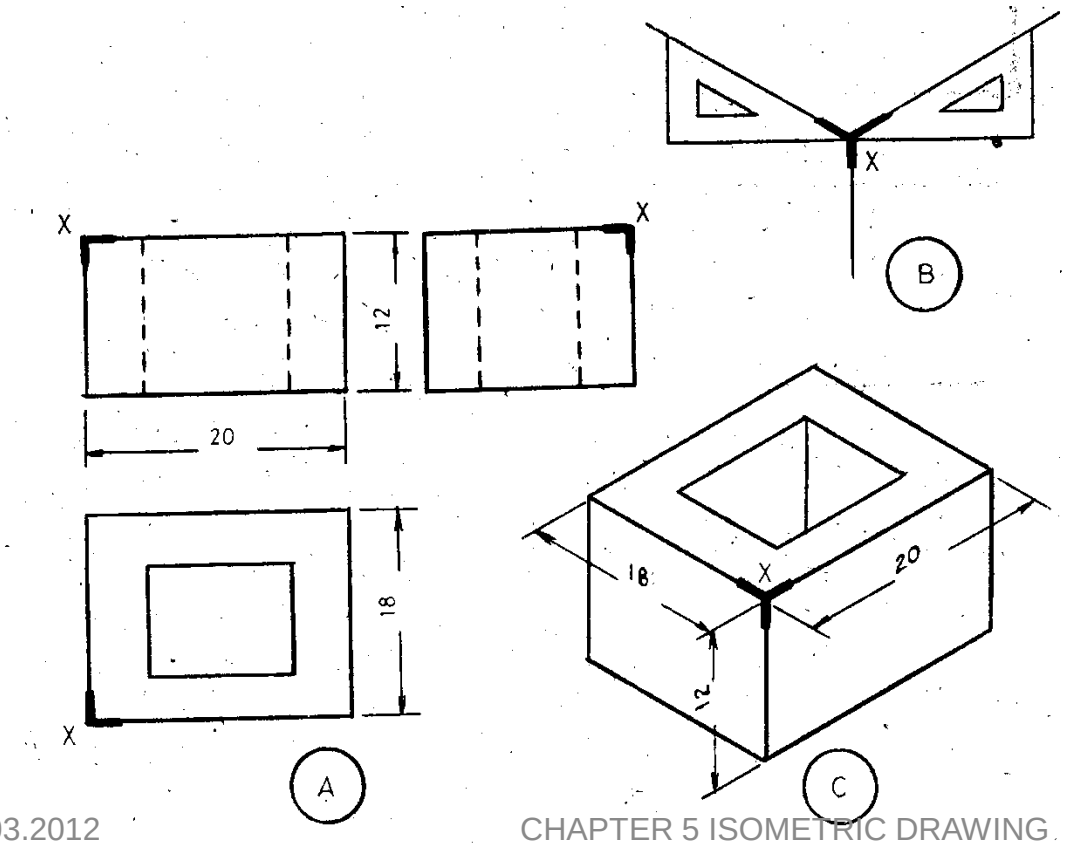


FIG. 5.5

If the object is rectangular (Fig. 5.5) start with a point representing a front corner (X), as shown at (A) with heavy lines, and draw from it three isometric axes 120º apart (B), one vertical, the other two with 30º triangle. On these three lines measure the height, width and depth of the object, as indicated at (C). Through the points so determined draw lines parallel to the axes, completing the figure. When drawing is isometric, remember the direction of the three principal isometric planes. Hidden lines are omitted except when they are needed to describe the piece.

It is often convenient to built up an isometric drawing from the lower front corner (Y), as illustrated in Fig.5.6. The location of the starting corner is again shown by heavy lines at (A), (B), and (C).

5.4 NONISOMETRIC LINES

Edges whose projections on drawings are not parallel to one of the isometric axes are called nonisometric lines. One important rule is that measurements can be made only on. the drawings of isometric lines; conversely, measurements can not be made on the drawing of the nonisometric lines. Compare the lengths of the diagonals on the cube in Fig.5.3.

Since a nonisometric line does not appear in the isometric drawing in its true length, the isometric view of each end of the line must be located and the isometric view of the line found by joining these two points.. In Fig.5.6., (A) and (C), the line JK is nonisometric edge whose true length can not be measured on the isometric drawing. However the vertical distances above the base to points J and K are parallel to the vertical isometric axes. These lines can, therefore be laid off, as shown at (C), to give the isometric view of the line JK.

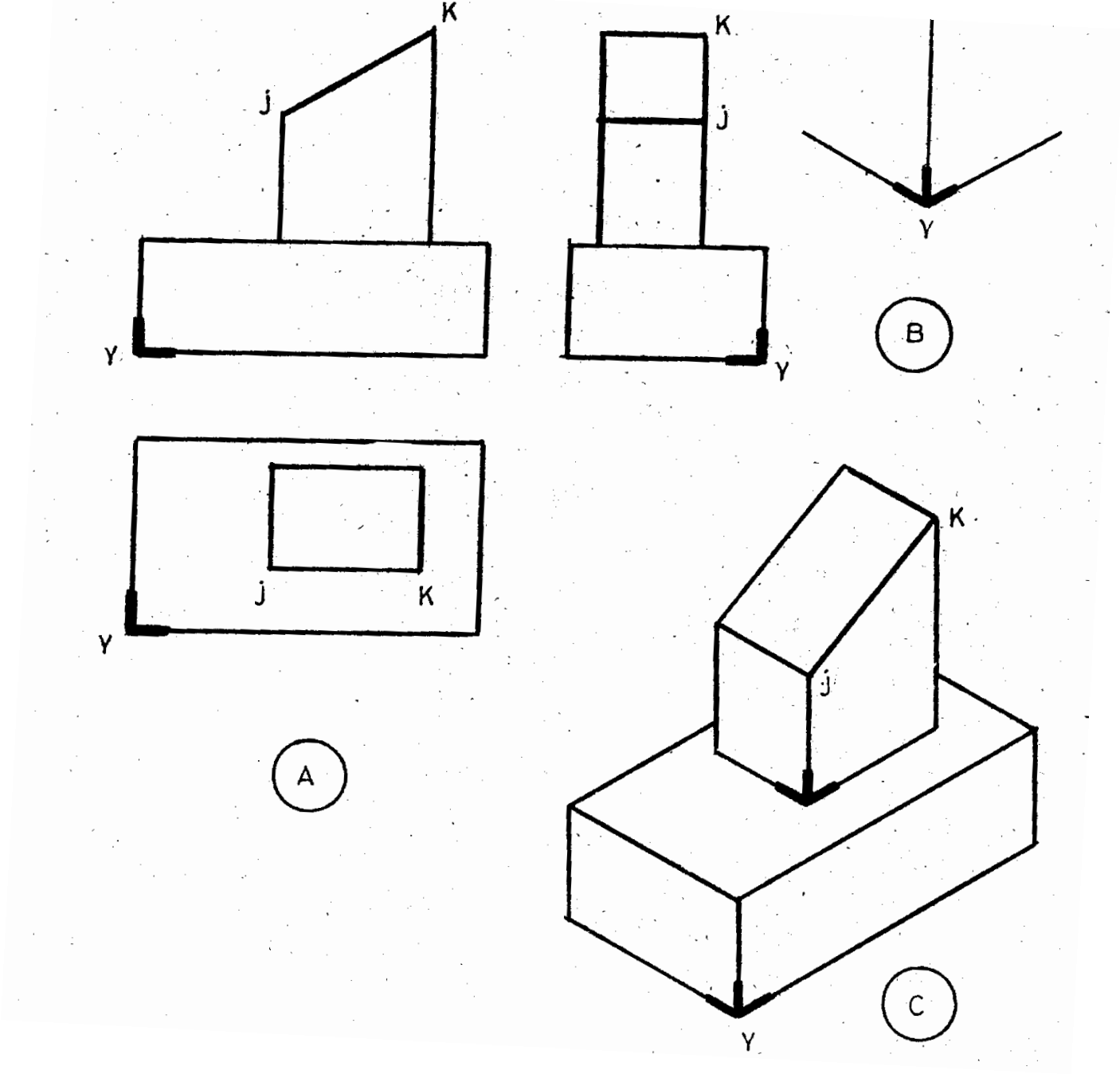


FIG.5.6

5.5 NONISOMETRIC LINES: BOXING METHOD

When an object contains many nonisometric lines, it is drawn by the boxing method or the offset method. When the boxing method is used, the object is enclosed in a rectangular box, which is drawn around it in orthographic projection. The box is then drawn in isometric and the object located in it by its points of contact as in Fig. 5.7. It should be noted that the isometric views of lines that are parallel on the object are parallel. This knowledge can often be used to save a large amount of construction. Fig. 5.7 might be drawn by putting the top face. into isometric and drawing vertical lines equal in length to the edges downward from each corner. In general, the boxing method is adapted to objects that have the nonisometric lines in isometric planes.

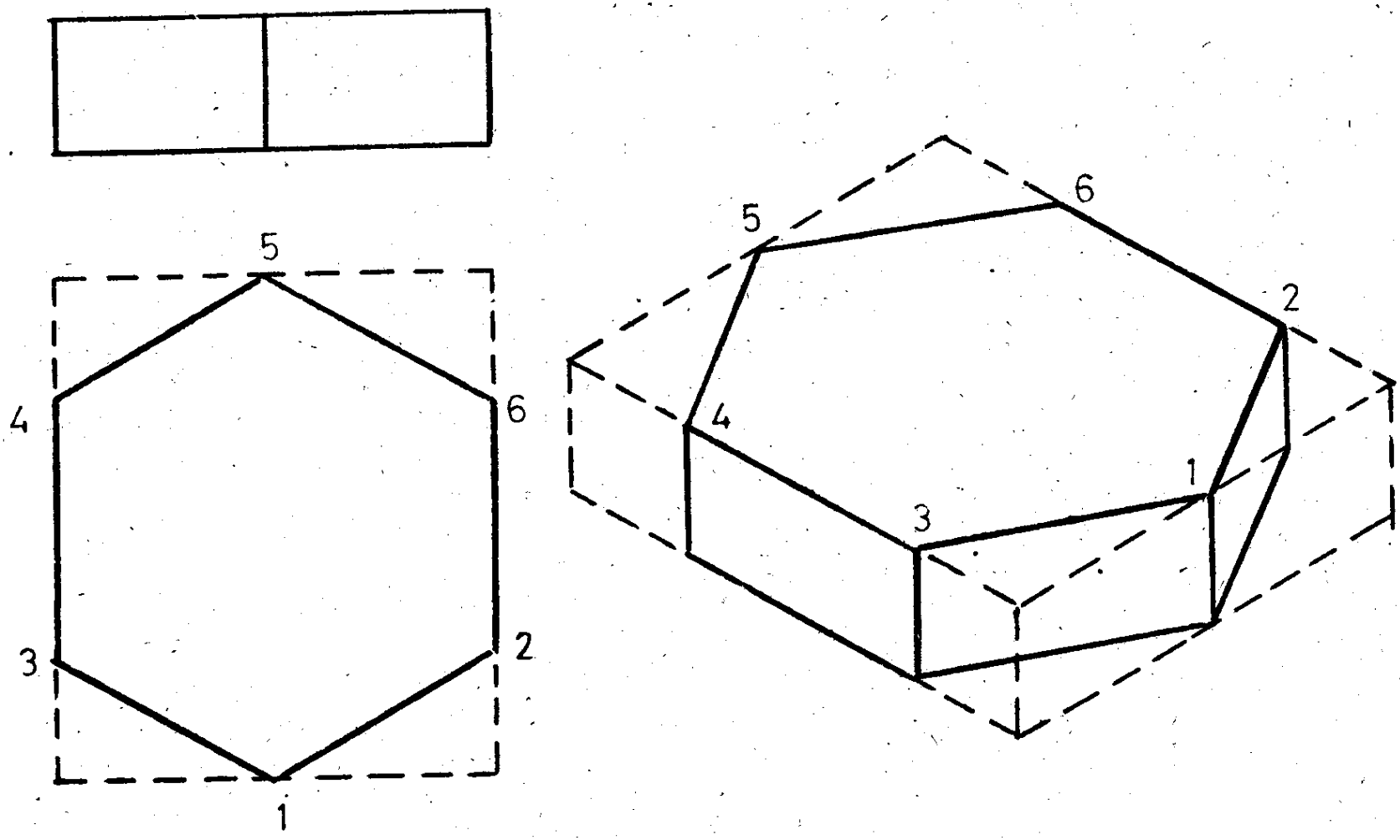
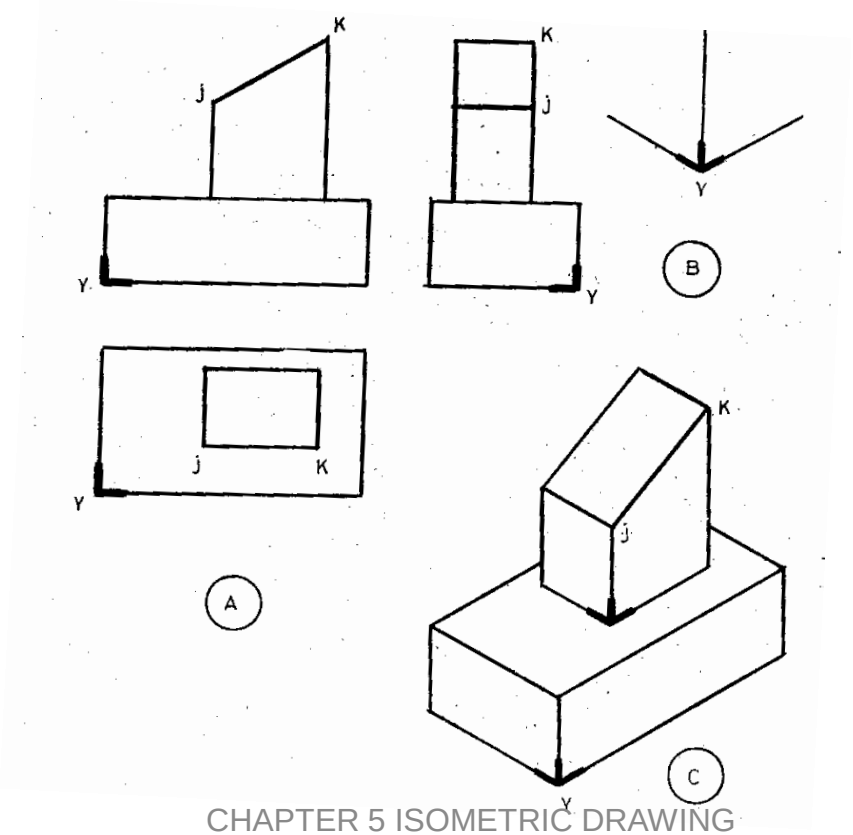


FIG.5.7

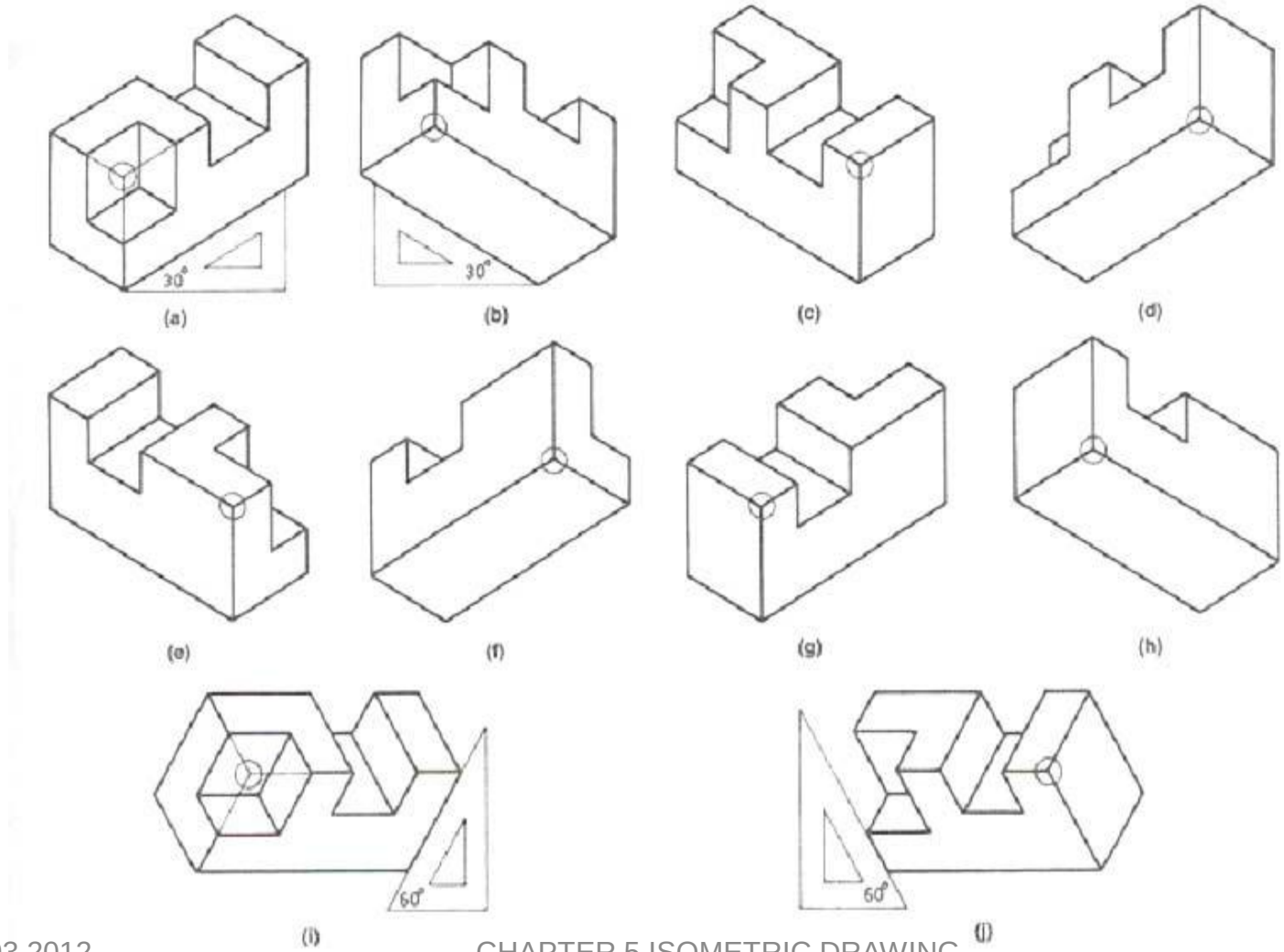
5.6 NONISOMEIRIC LINES: OFFSET METHOD

When an object is made up of planes at different angles, it is better to locate the ends of the edges by the offset method rather than by boxing. When offset method is used, perpendiculars are extended from each point to an isometric reference plane. These perpendiculars, which are isometric lines, as located on the drawing by isometric coordinates, the dimensions being taken from the orthographic views. In Fig.5.6 points J and K can be located in this manner.



Selection of Isometric axes

- View **(a)** is preferred as it reveals more detail than the others

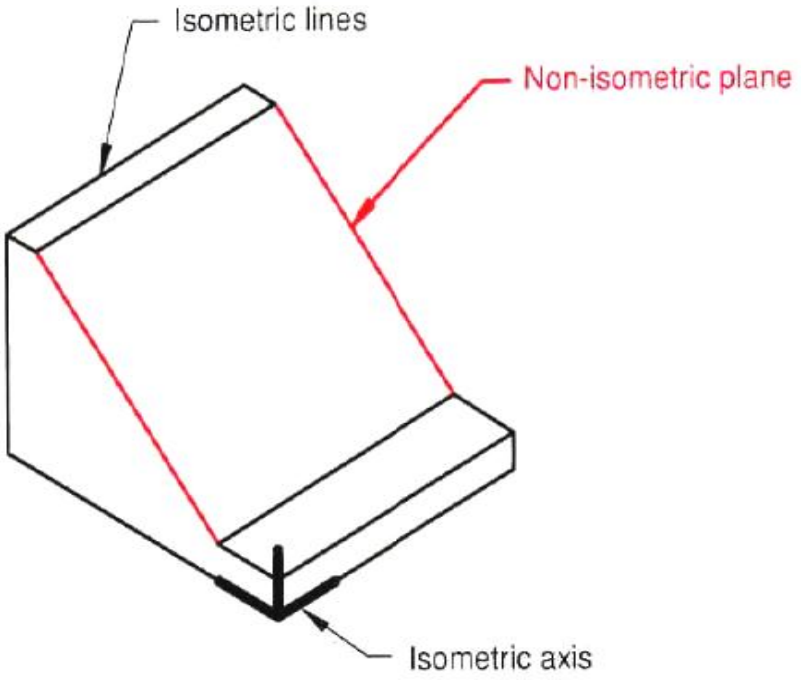


Isometric and Non-isometric lines & planes

❑ In an isometric drawing, true length distances can only be measured along isometric lines, that is, lines that run parallel to any of the isometric axes.

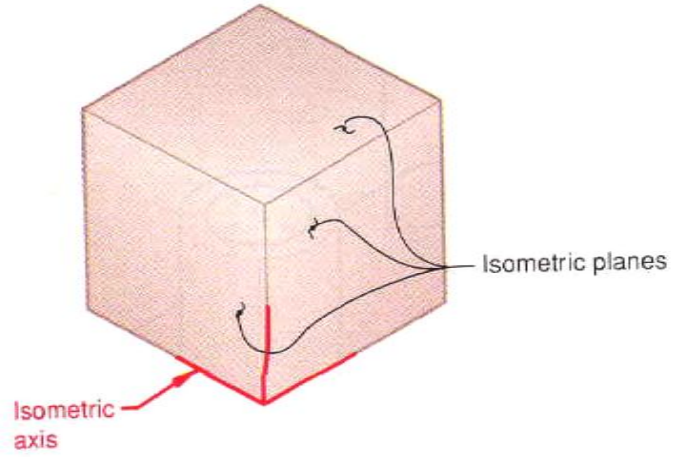
❑Any line that does not run parallel to an isometric axis is called a **non-isometric line**

❑ Non-isometric lines include inclined and oblique lines and can not be measured directly. Instead they must be created by locating two end points.

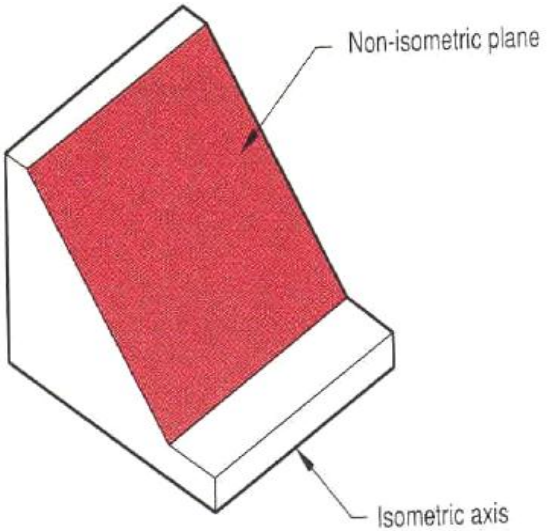


Isometric and Non-isometric lines & planes

- The three faces of the isometric cube are isometric planes, because they are parallel to the isometric surfaces formed by any two adjacent isometric axes.



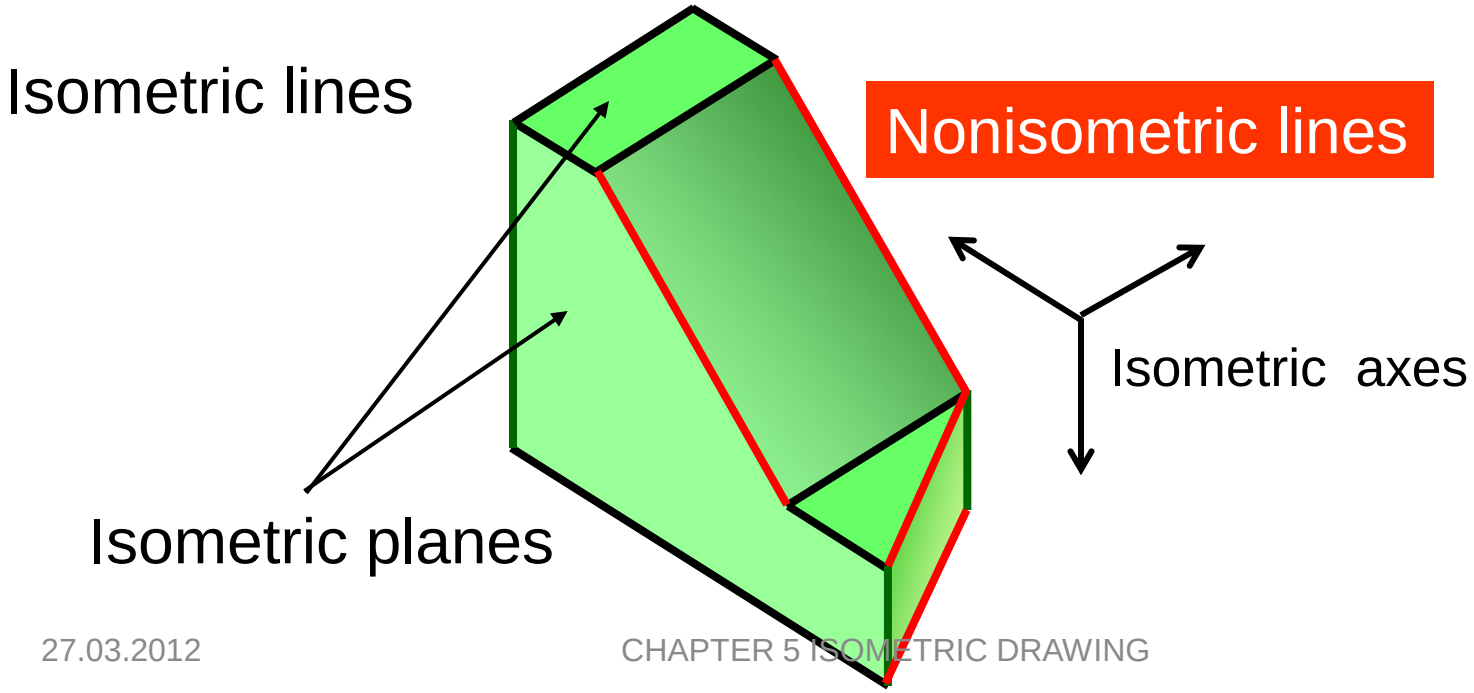
- Planes that are not parallel to any isometric plane are called non-isometric planes



Isometric and Non-isometric lines & planes

- **True-length distances** are shown along isometric lines.

- ***Isometric line*** is the line that run ***parallel*** to any of the isometric axes.



Isometric drawing

The Boxing-in Method for Creating Isometric Drawings –

The four basic steps for creating an isometric drawing are:

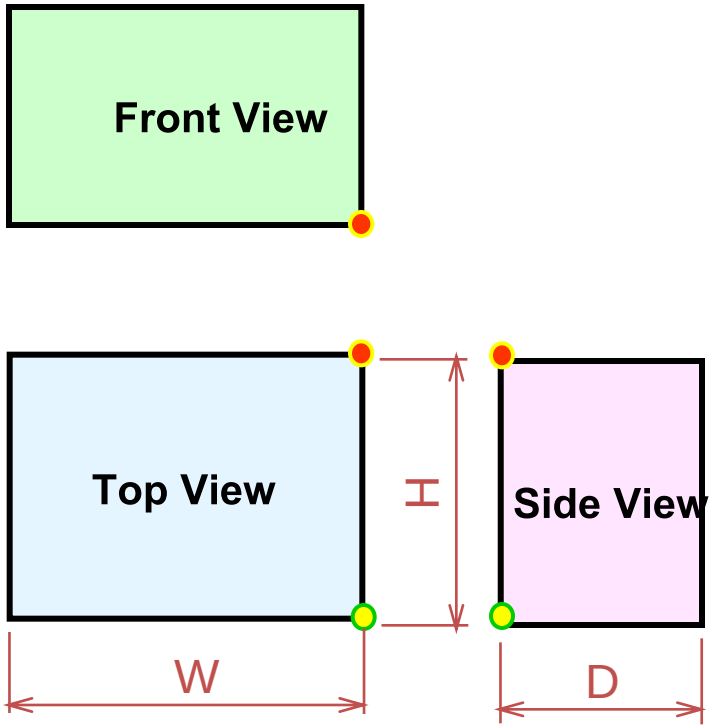
1. Determine the isometric viewpoint that clearly depicts the features of the object, then draw the isometric axes which will produce that view-point.

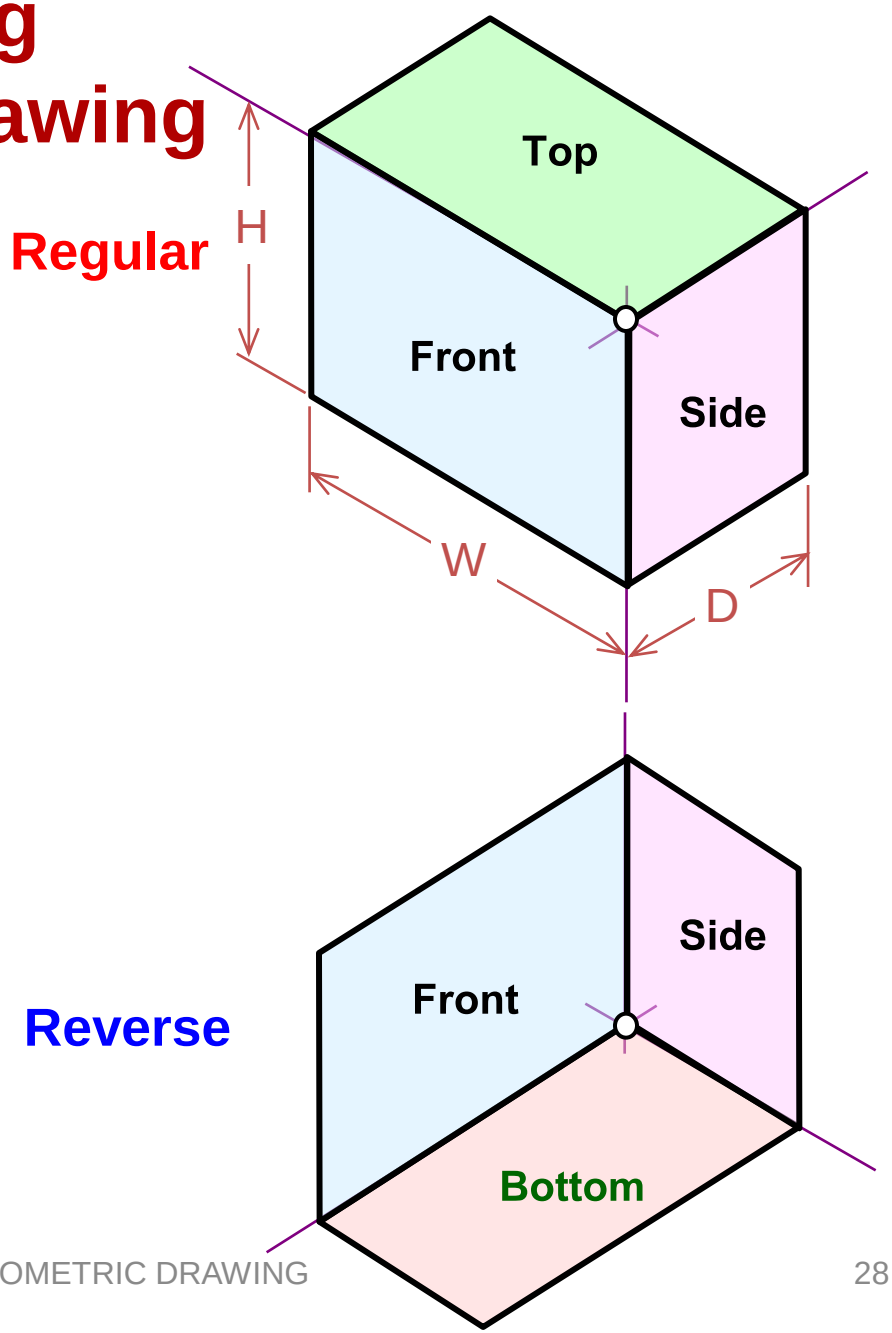
2. Construct isometric planes, using the overall width (W), height (H), and depth (D) of the object, such that the object will be totally enclosed in a box.

3. Locate details on the isometric planes.

4. Darken all visible lines, and eliminate hidden lines unless absolutely necessary to describe the object.

Isometric sketching from multi-view drawing

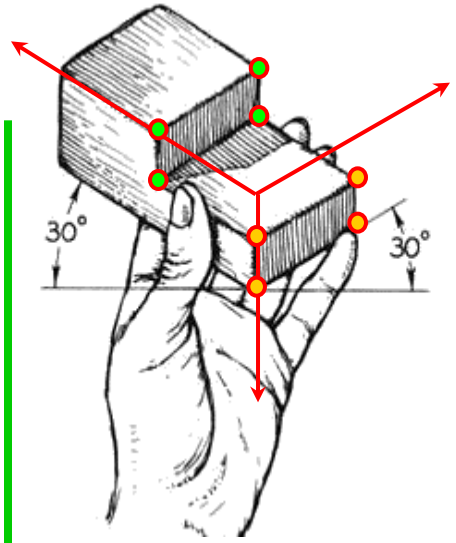


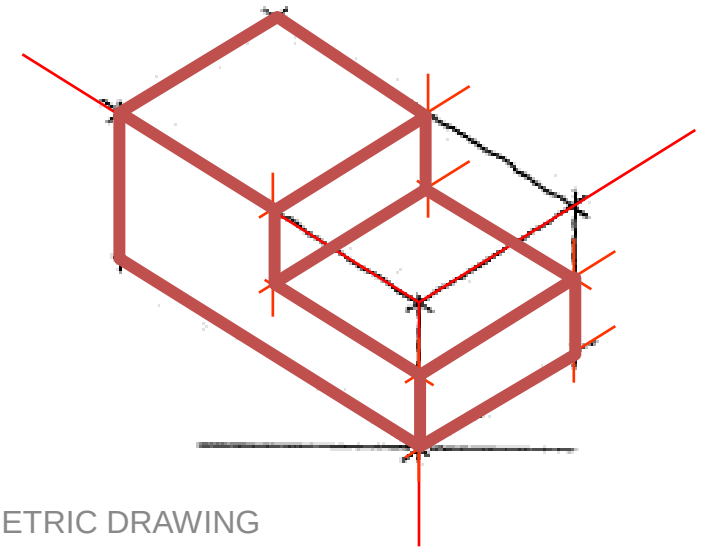


Isometric drawing

STEPS

1. Positioning object.
2. Select isometric axis.
3. Sketch enclosing box.
4. Add details.
5. Darken visible lines.





Isometric drawing

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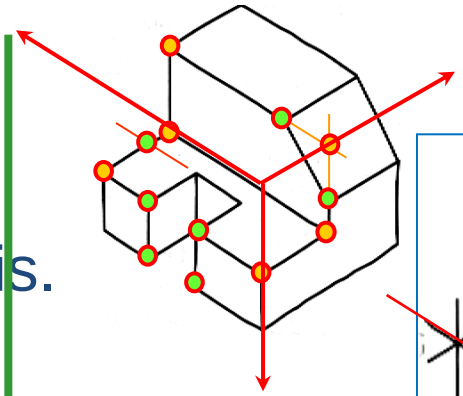
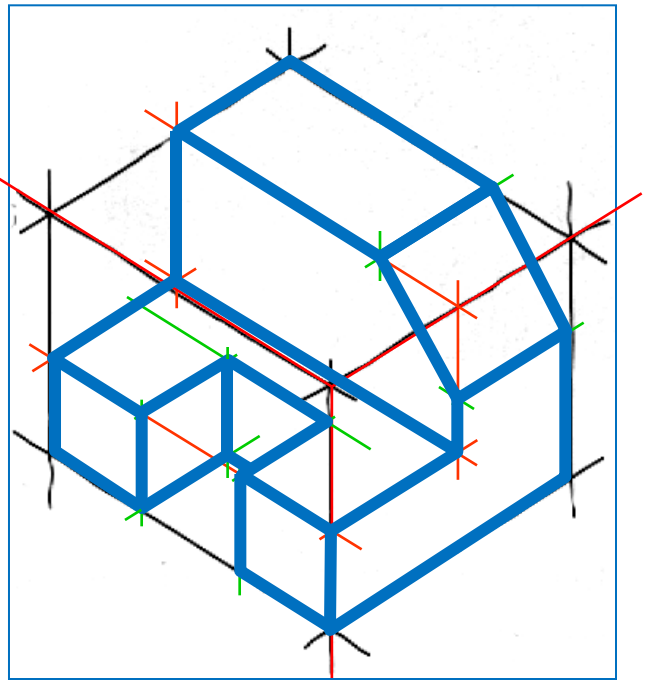
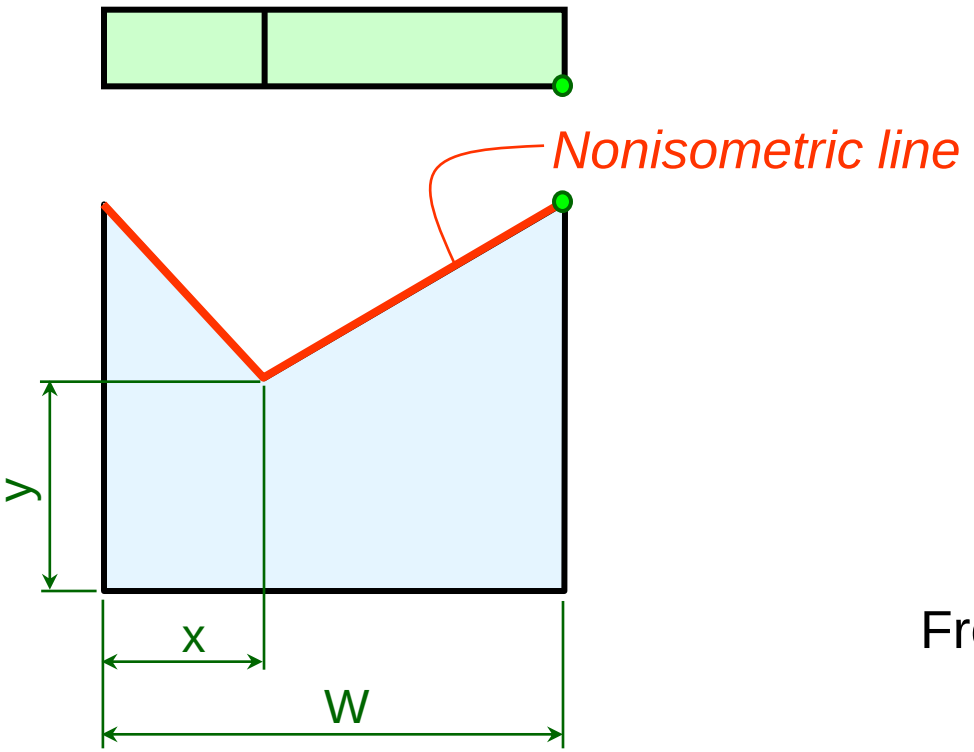
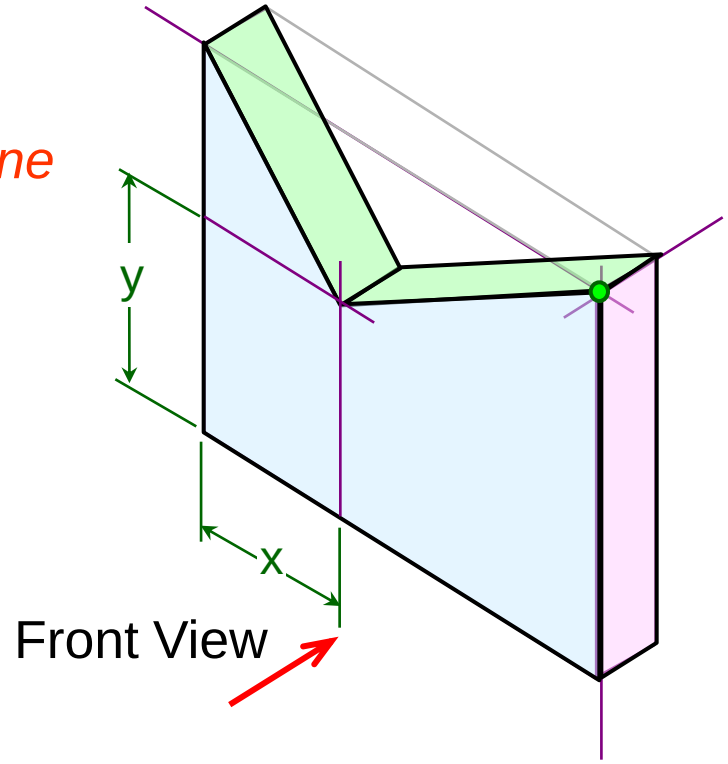




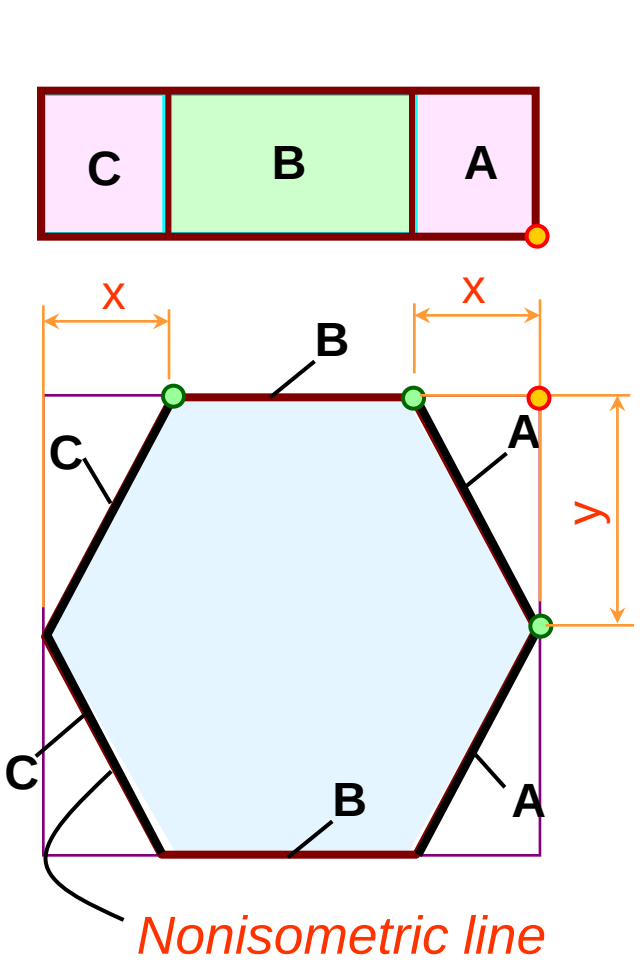
Note In isometric sketch/drawing, hidden lines are ***omitted*** unless they are absolutely necessary to completely describe the object.

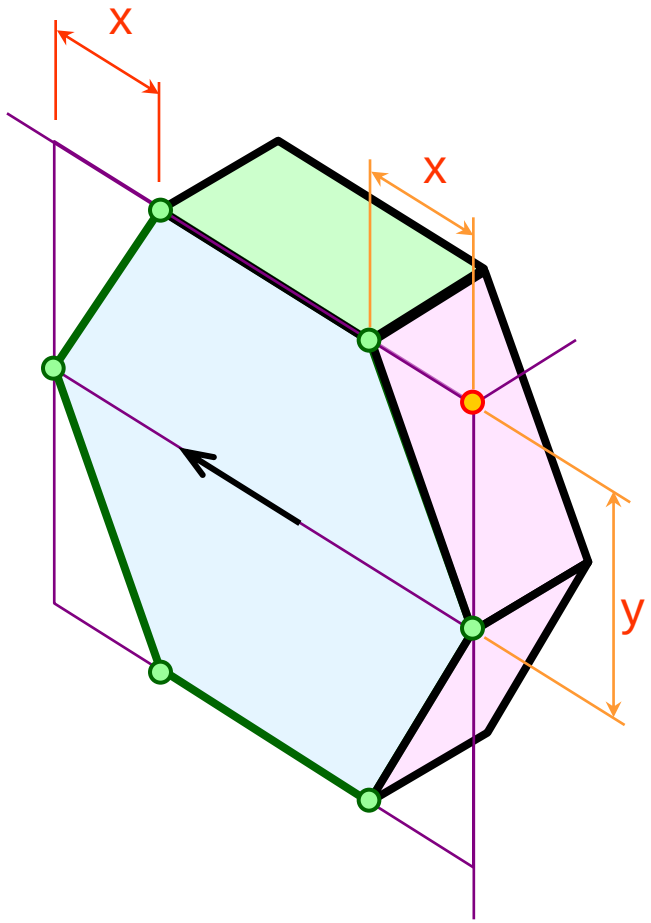
Isometric drawing: object has inclined surfaces



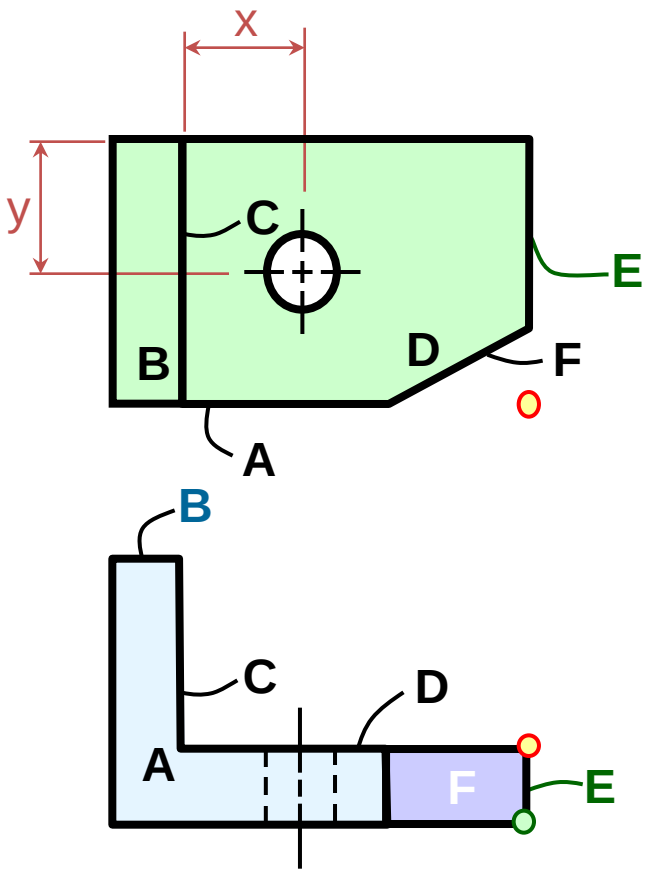


Isometric drawing: object has inclined surfaces

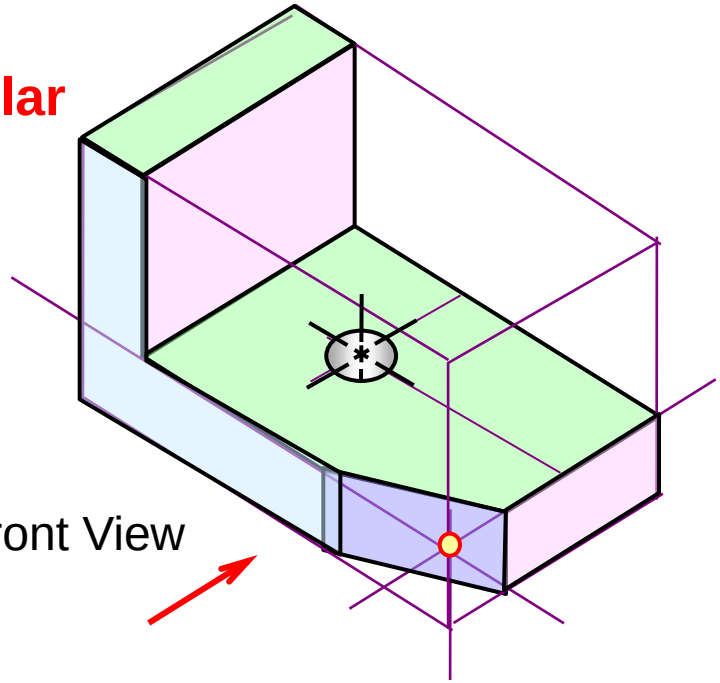




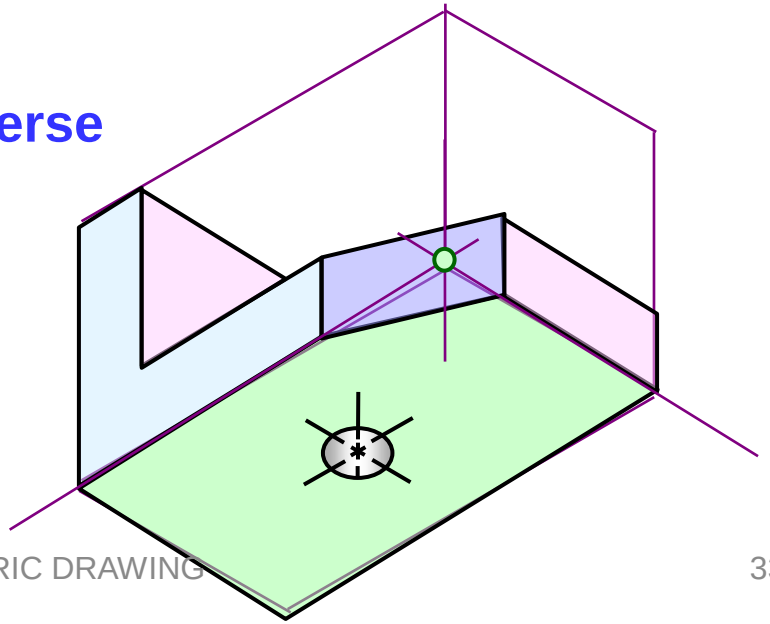
Isometric drawing



Regular



Reverse

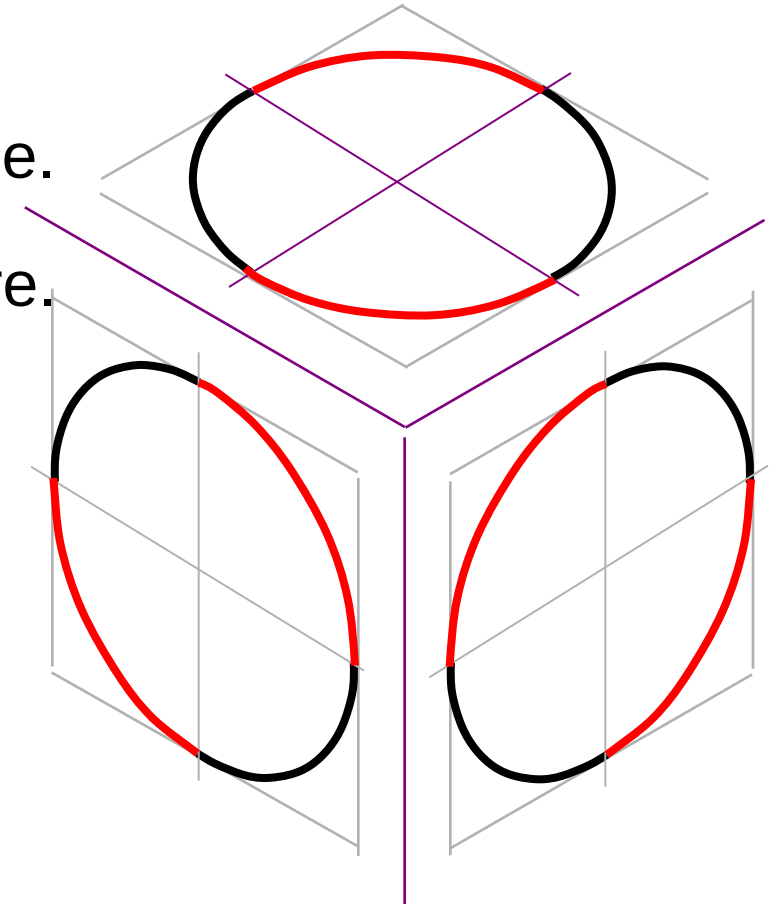


Drawing of Circle and Arcs

- In isometric drawing, a circle appears as an ellipse

Sketching Steps

1. Locate the centre of an ellipse.
2. Construct an isometric square.
3. Sketch arcs that connect the tangent points.

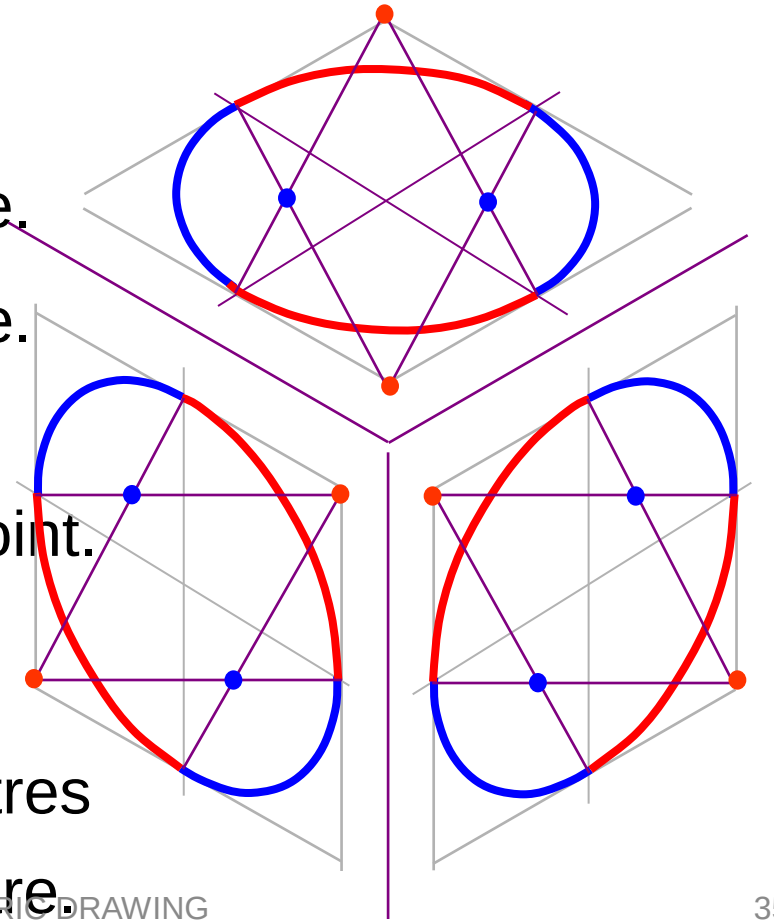


Drawing of Circle and Arcs

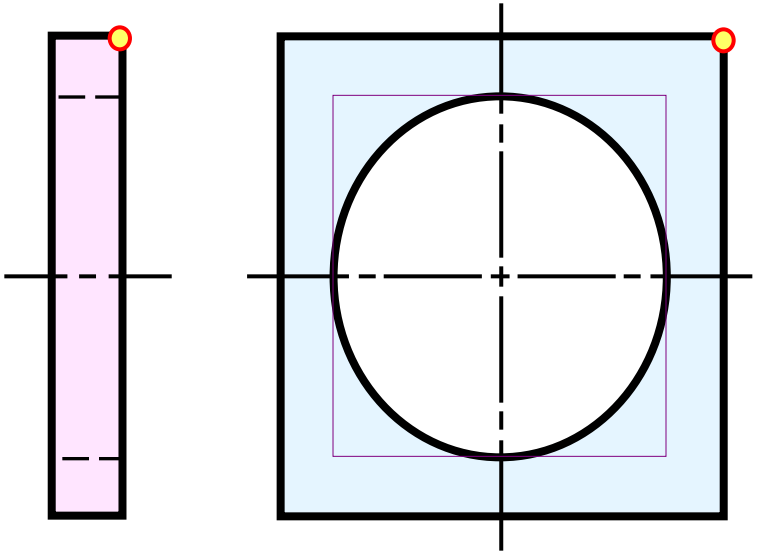
- ***Four-centre*** method is usually used when drawn an isometric ellipse with drawing instrument.

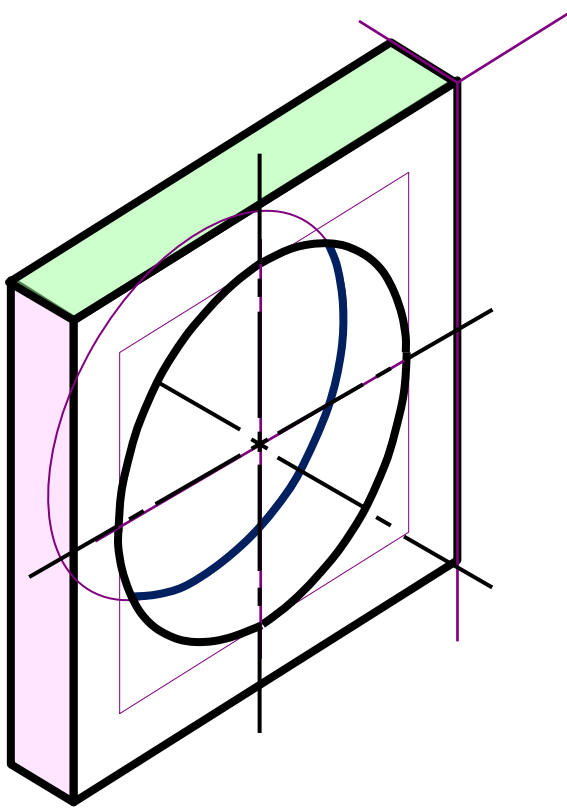
Sketching Steps

1. Locate the centre of an ellipse.
2. Construct an isometric square.
3. Construct a perpendicular bisector from each tangent point.
4. Locate the four centres.
5. Draw the arcs with these centres and tangent to isometric square.

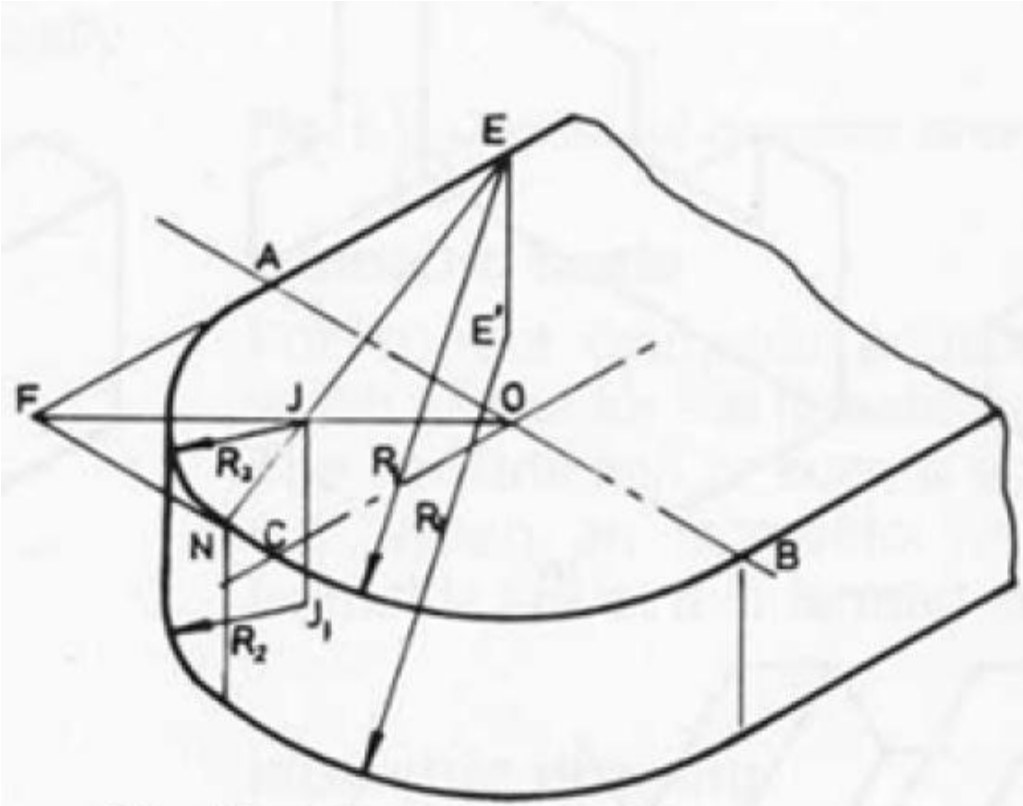


Drawing of Circle and Arcs





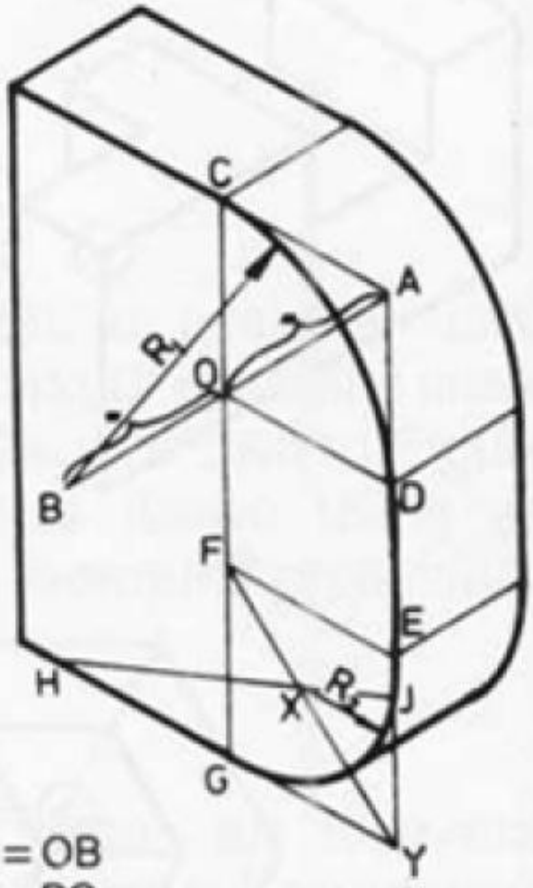
Drawing of Circle and Arcs



FA = AE = FJ = radius of end

R_1 = EC R_2 = JN

Half circle



OA = OB

R_1 = BC

XY = YG = GH = radius of circle

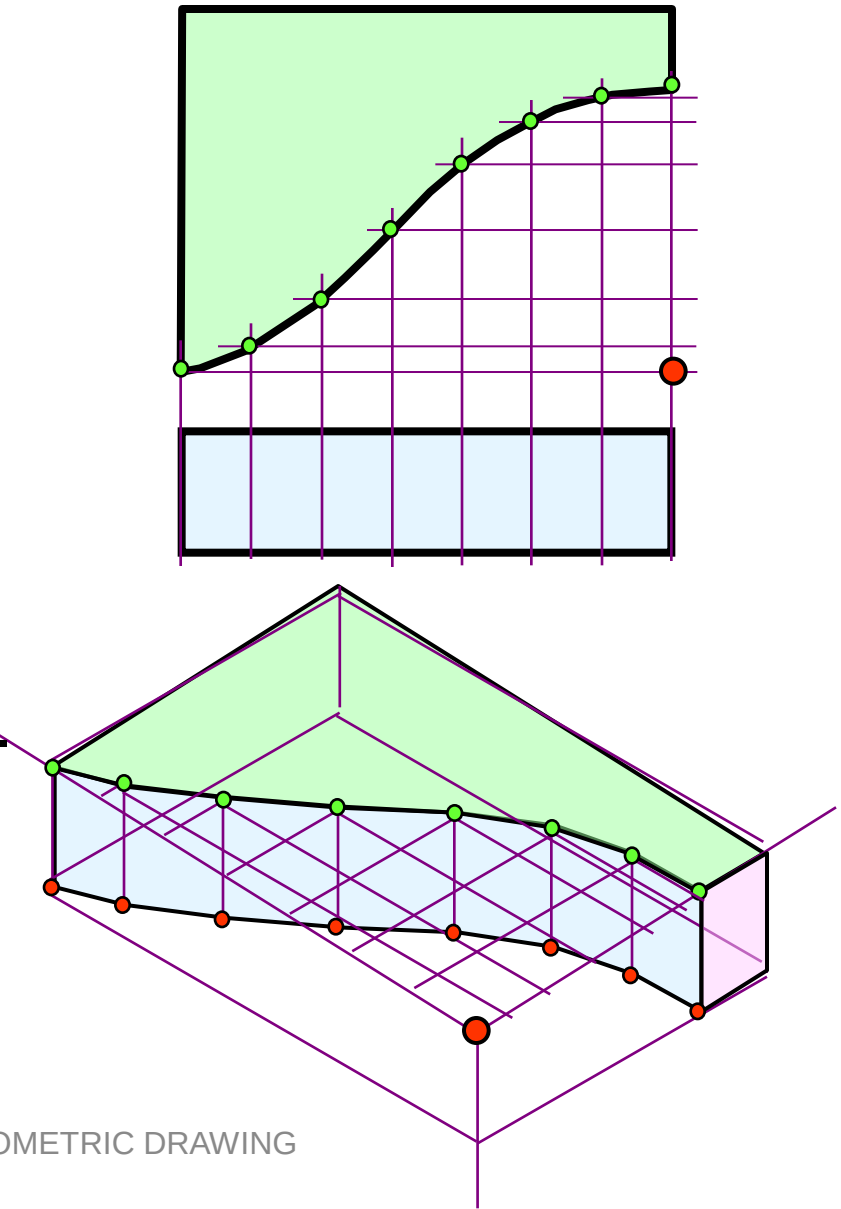
R_2 = XJ

Quarter circle

Drawing of Irregular curves in Isometric drawing

Steps

1. Construct points along the curve in multiview drawing.
2. Locate these points in the isometric view.
3. Sketch the connecting lines.

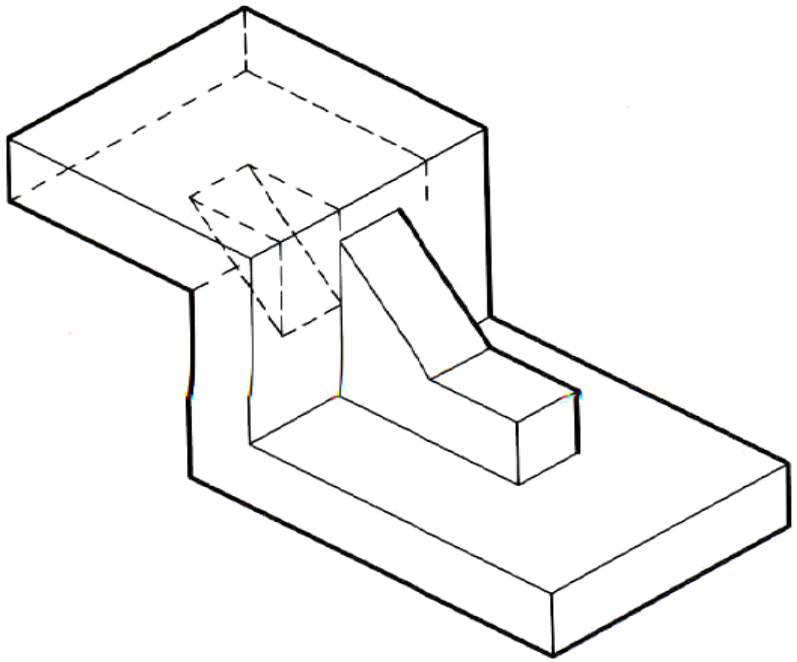


Hidden lines in Isometric drawing

- In isometric drawings, hidden lines are omitted unless they are absolutely necessary to completely describe the object. Most isometric drawings will not have hidden lines.

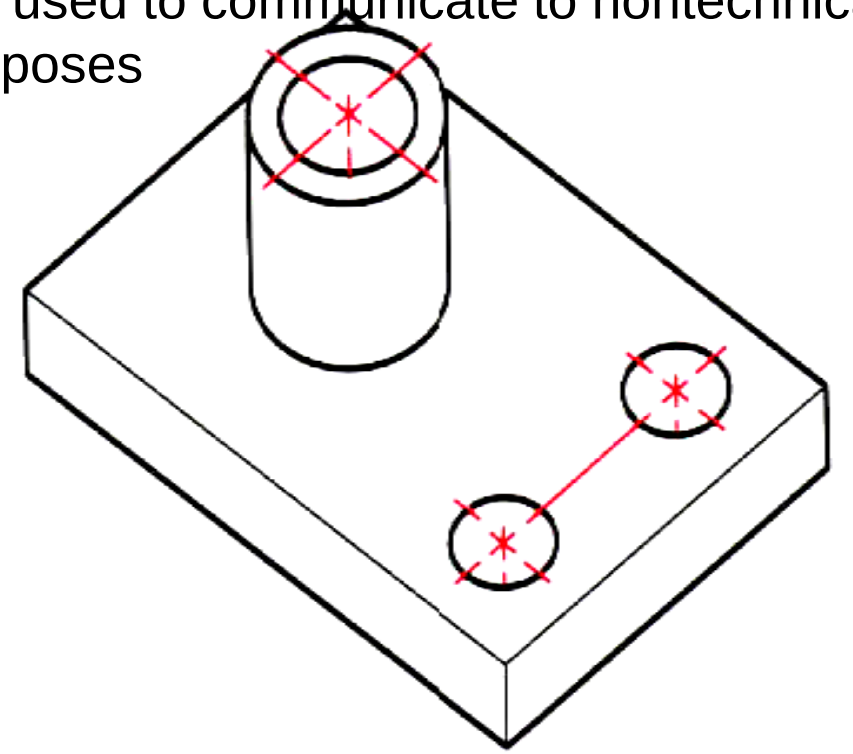
- To avoid using hidden lines, choose the most descriptive viewpoint.

- However, if an isometric viewpoint cannot be found that clearly depicts all the major features, hidden lines may be used.



Center lines in Isometric drawing

❑ **Centerlines are drawn only for showing symmetry or for** dimensioning. Normally, centerlines are not shown, because many isometric drawings are used to communicate to nontechnical people and not for engineering purposes



5.7. ANGLES IN ISOMETRIC

The three isometric axes, referred back to the isometric cube, are mutually perpendicular but in isometric drawing appear at 120º to each other. For this reason, angles specified in degrees do not appear in their true size on an isometric drawing and must be laid off by coordinates that will be parallel to the isometric axes (Fig.5.8.)

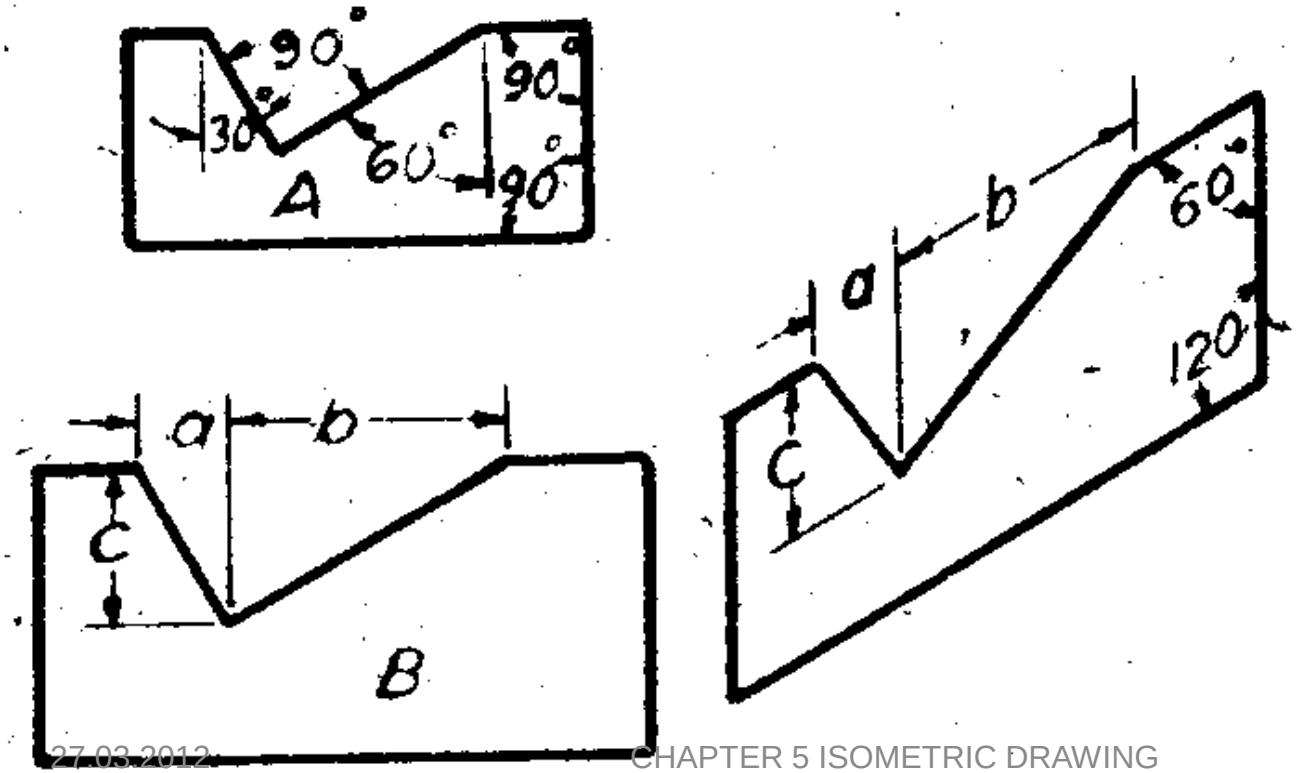


Fig.5.8 Angles in isometric. These must be laid out by offsets from and orthographic view to the same scale.

5.8. CURVES IN ISOMETRIC

A circle or any other curve will not show in its true shape when drawn in isometric. A circle on any isometric plane will be an ellipse, and a curve will be shown as the isometric projection of the true curve.

A curve can be drawn by plotting points on it from isometric reference lines or coordinates that are parallel to the isometric axes, as shown in Fig. 5.9.

A circle plotted in this way is shown in Fig. 5.10.

Note that in both figures coordinates (a) and (b) are parallel to the isometric axes and the coordinate distances must be obtained from an orthographic view drawn to the same scale as the isometric.

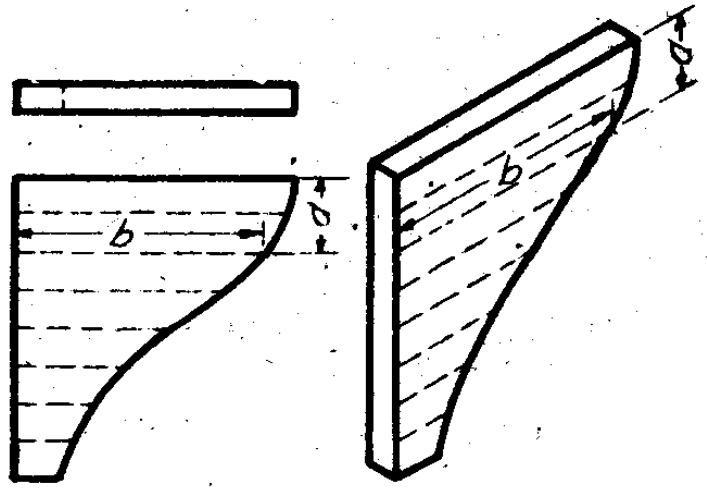


Fig. 5.9 Curves in isometric. Points are transferred from the orthographic view to the pictorial by offsets. Identical scale must be used.

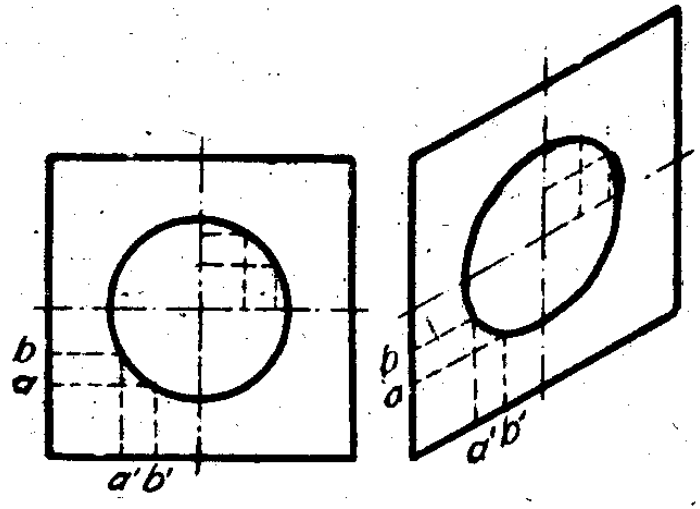


Fig. 5.10 Isometric circle, points plotted. Points are transferred from the orthographic view to the pictorial by offsets. Identical scale must be used.

5.9 CIRCLES IN ISOMETRIC

In Fig.5.11, coordinates (a) and (b) have located points on the circle, and these ordinates have been transferred to the isometric view to given points on the ellipse. The ellipse is completed with a french curve.

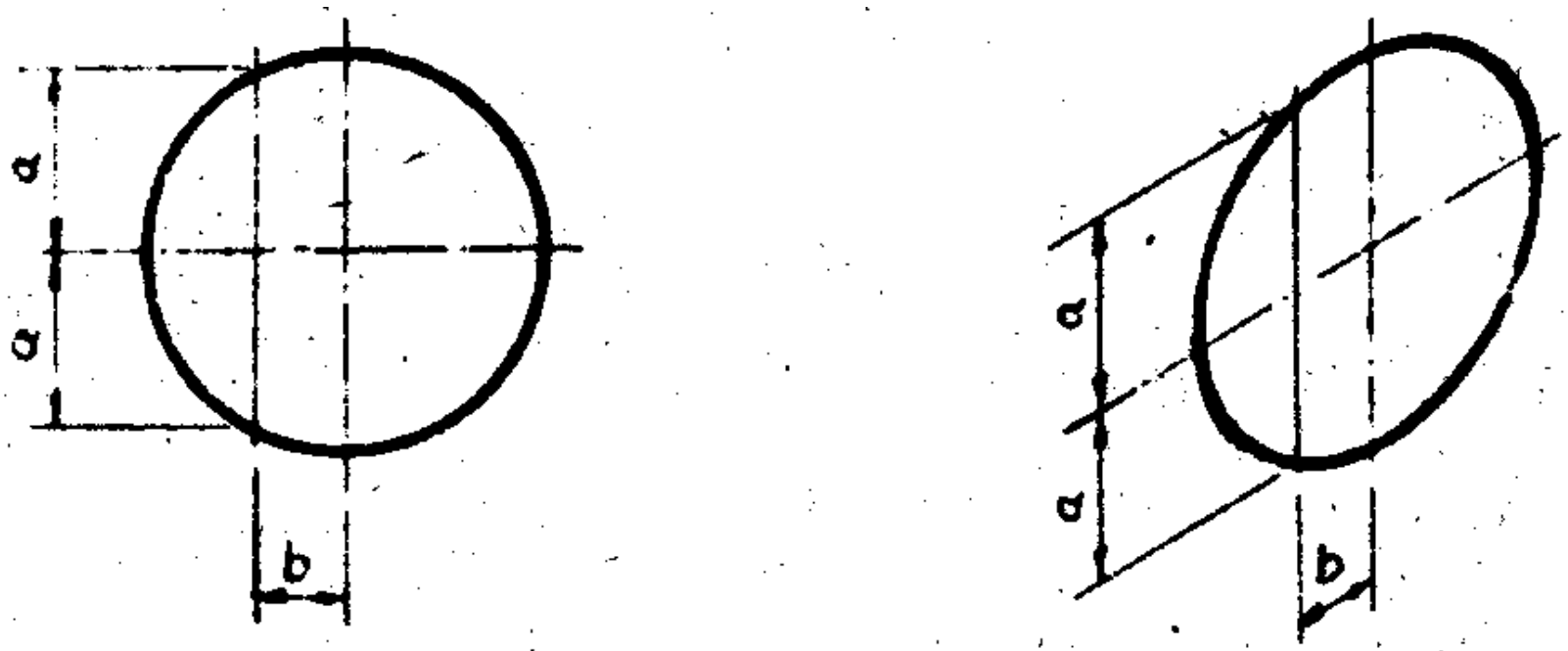


FIG. 5. 11

The circle in Fig.5.12 has been circumscribed by a square and the diagonals have been drawn. This square is redraw in the isometric view and eight points on the ellipse are obtained by the intersection of the centre lines and the square, and the diagonals and the circle. The coordinates (a) fix the points on the diagonals. The ellipse is completed as before with a French curve.

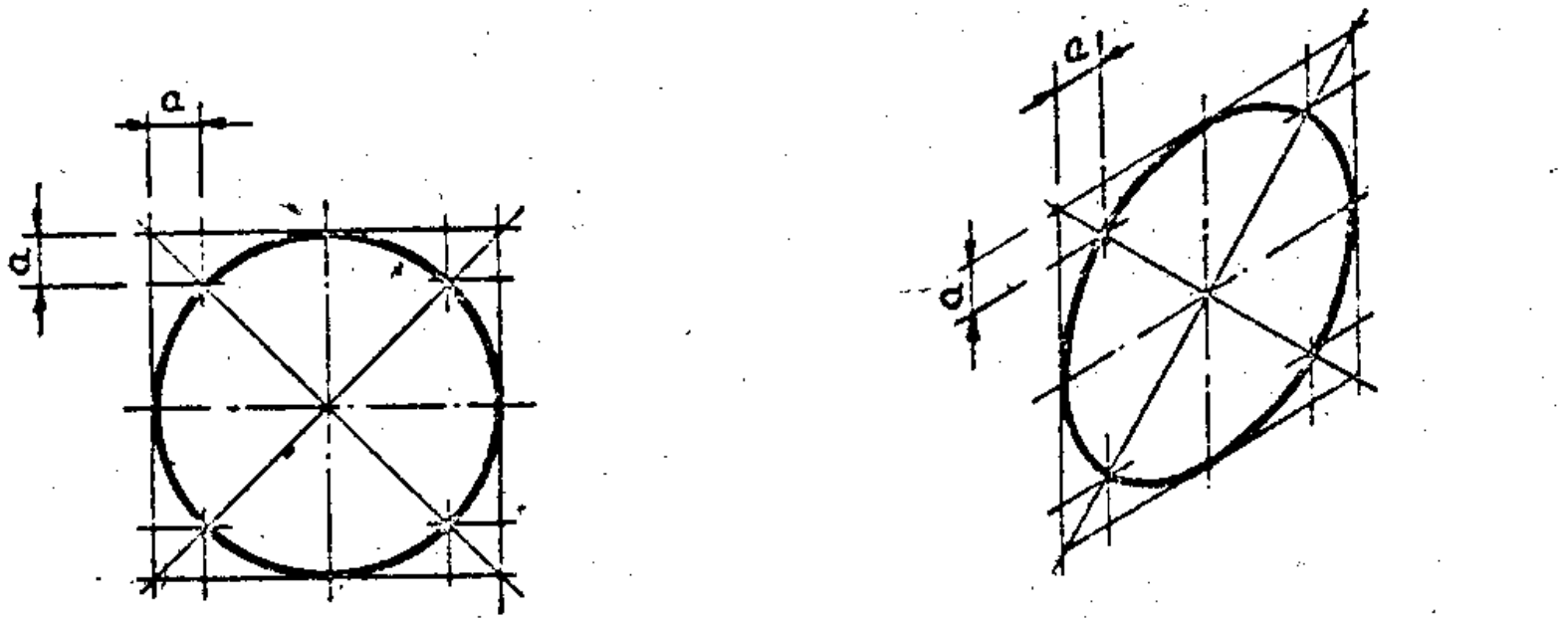


FIG. 5. 12

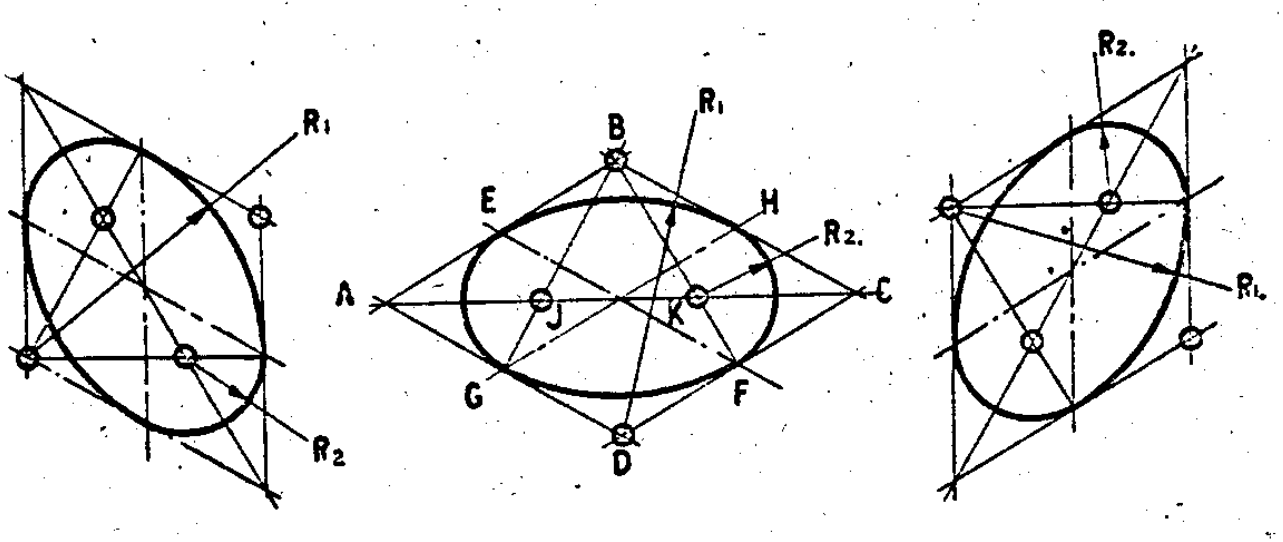


FIG. 5. 13

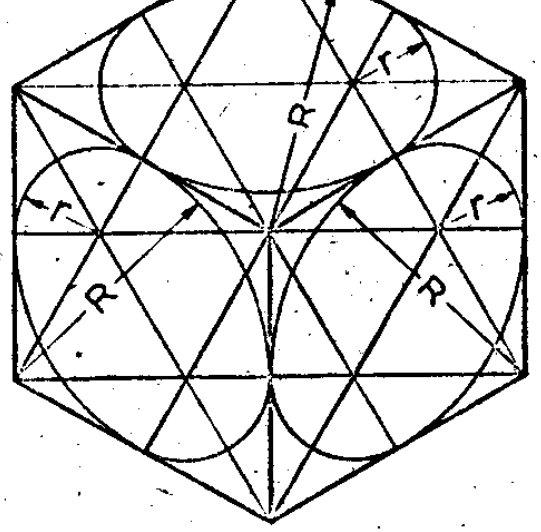


Fig.5.14 Four-Centre Ellipses.

APPROXIMATE FOUR CENTRE ELLIPSE:

The ellipse occurs so frequently on isometric drawings that an approximate method using circular arcs in generally used to draw it. One such method is shown in Fig.5.13, and Fig.5.14. The centre lines EF and GH are first drawn and their intersection is made centre of an isometric square ABCD with edges equal to the diameter of the required circle. The long diagonal AC of the square is drawn and either D or B is joined to midpoints of opposite sides. Where these lines cross the long diagonal at J and K are two centres for circular arcs to draw the ellipse approximately. The other centres are the corners B and D of the isometric square.

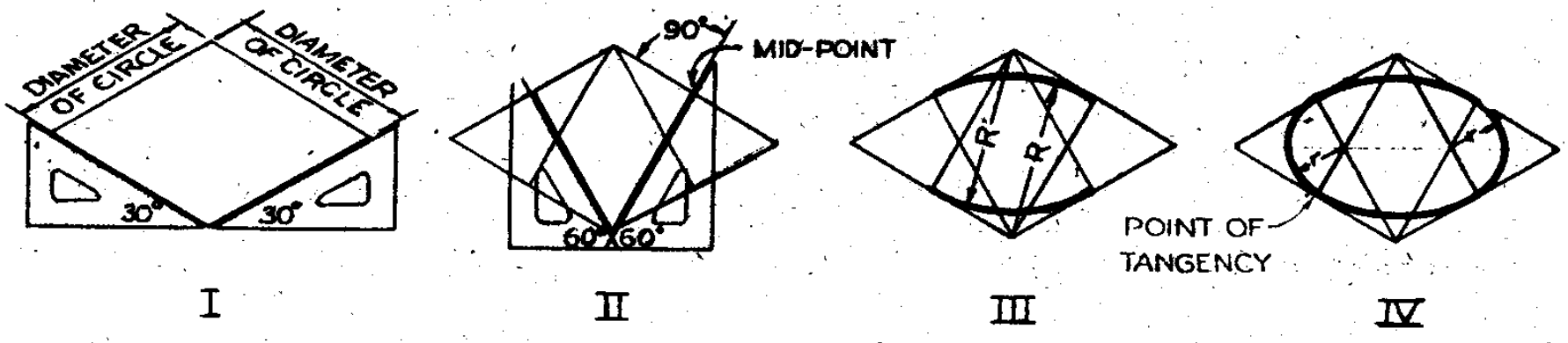


Fig. 5.15 Steps in Drawing Four-Centre EIlipse.

Steps in drawing a four-centred ellipse very similar to the above construction are shown in Fig.5.15.

Draw a square around the given circle in the orthographic drawing. Then;

1. Draw the isometric of the square, with its long diagonal, which is an equilateral parallelogram whose sides are equal to the diameter of the circle.
2. Erect perpendicular bisectors to each side, using the 30º-60º triangle as shown. These perpendiculars will intersect at four points, which will be the centres for the four circular arcs.
3. Draw the two large arcs with radius (R) from the intersections of the perpendiculars in the two closest corners of the parallelogram, as shown.
4. Draw the two small arcs with radius (r) from the intersections of the perpendiculars within the parallelogram, to complete the ellipse.

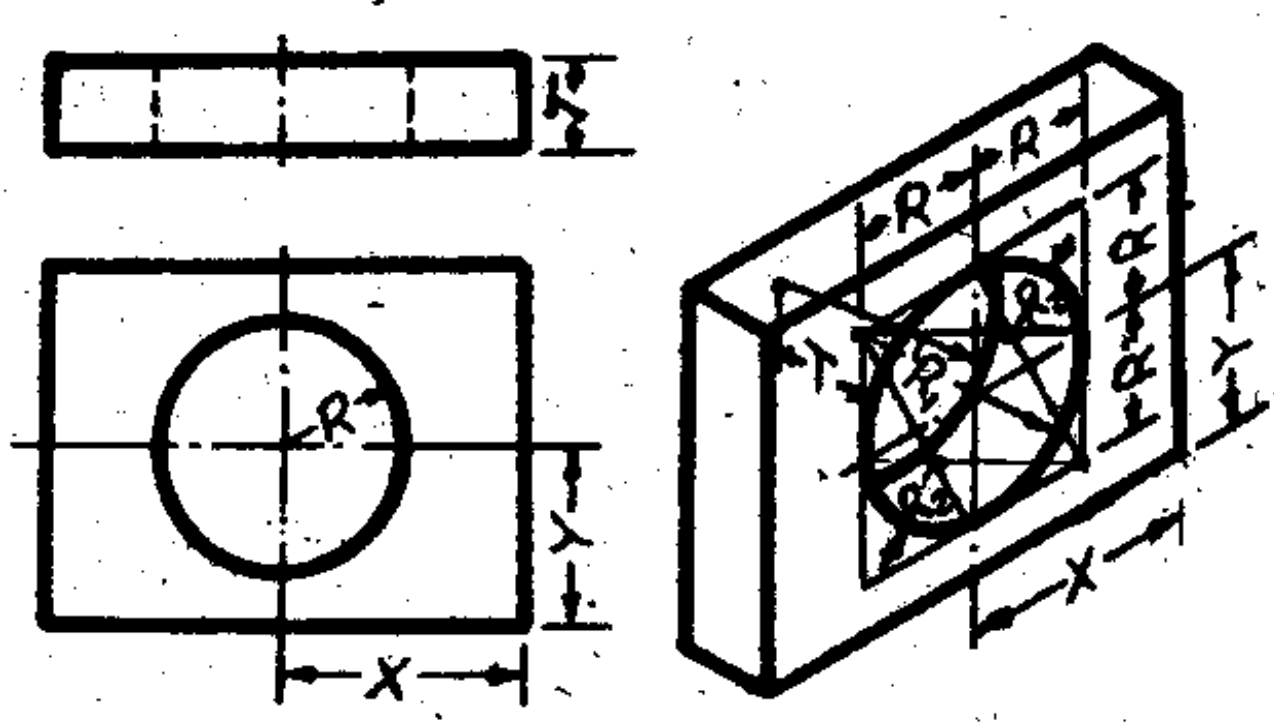


Fig. 5.16 Locating and Laying out a hole in isometric. Locate the centre, draw the enclosing isometric square, and then draw the circle.

Fig. 5.16 shows the method of locating and laying out a hole in isometric from given orthographic views. First locate and then draw the centre lines for the hole by laying out the distances X and Y as shown.

On these lines, construct an isometric square (parallelogram) with sides equal to the diameter of the hole by laying out the radius R in each direction from the intersection of the centre lines. Then use the four centred method ellipse construction as explained above. Should the piece be thin enough, a portion of the back side of the hole will be visible. To determine this, drop the thickness (T) back on an isometric line and swing large radius R of the isometric circle with this point as centre. If the arc thus drawn comes within the boundary of the isometric circle, that portion of the back will be visible. In extra thin pieces, portions of the small arcs R_2 might be visible. This should be determined the same way. (The isometric projection of a sphere would be a circle of the actual diameter of the sphere).

5. 10 ISOMETRIC CIRCLE ARCS

To draw any circle arc draw the isometric square of its diameter in the plane of its face, with as much of the four-centre construction as is necessary to find centres of the part of the circle needed, as shown in Fig. 5.17. The arc occurring most frequently is the quarter circle.

Note in illustrations (D) and (E) only two construction lines are needed to find the centre of a quarter circle-in an isometric plane. Measure the true radius R of the circle from the corner on the two isometric lines as shown, and draw actual perpendiculars from these points. Their intersection will be required centre for radius R_1 or R_2 of the isometric quadrant. (F) illustrates the construction for the two vertical isometric planes.

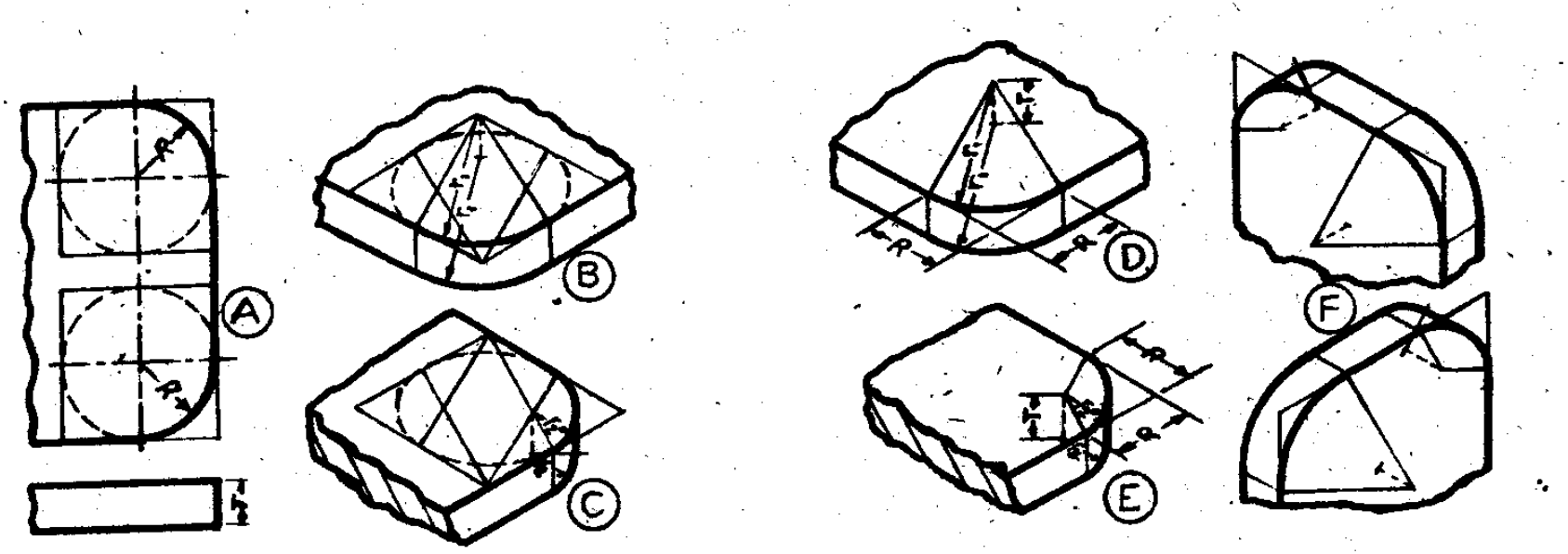


FIG. 5.17 Isometric quarter circles. The radius centre lies on perpendiculars from tangent points that are the radius distance from the corner.