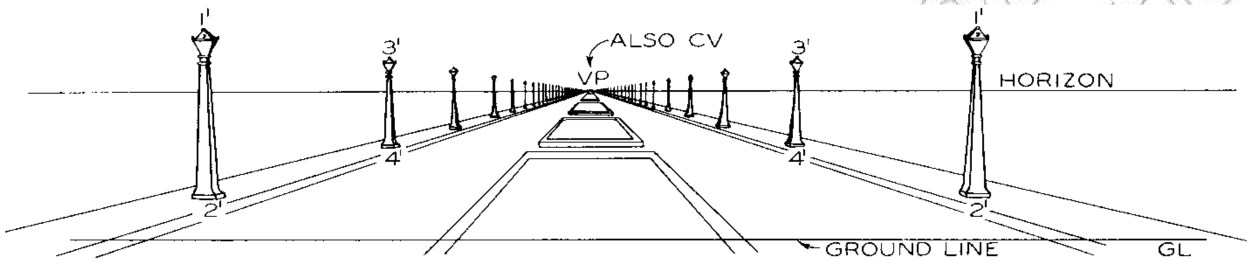
# UNIT 7

# PICTORIAL DRAWING




One point perpective

**Learning Competencies:**

***Up on completion of this unit you should be able to:***

- ✓ **To identify the different types of projection systems;**
- ✓ **To develop the necessary level of competence in order to make pictorial representations using: Isomeric drawings, Oblique drawings, and Perspective drawings;**
- ✓ **To understand the relationship of width, height and depth of an object in various types of pictorial representations;**
- ✓ **To decide upon the type of pictorial representation (isomeric or oblique), which is best suited for particular needs;**
- ✓ **To apply the proper construction procedures to make pictorial drawings;**
- ✓ **To decide upon the position that shows the object to the best advantage in oblique or isomeric drawings.**

## 7.1 Introduction

In multi-view representation of an object, two or more views are used to describe its form or shape and size accurately. However, since each of the views shows only one face and two principal dimensions of an object at a time without any suggestion of the third principal dimension, such a representation can convey full information only to the professionals familiar with the graphic language i.e. technical drawing used mainly by engineers, architects, draftsman, and contractors. To this end, the professionals use conventional picture representations to communicate with other people who do not possess the required visualization skill to construct an object in the mind from its multi-view drawing. This pictorial represent-tation of an object showing the three faces on a single plane to represent an object in its realistic appearance is known as pictorial drawing. Or pictorial drawing is a drawing by which shape and size of an object is expressed in three dimensions to show the three faces (i.e. height, width and depth).

Multi-view drawings are two dimensional drawings where as pictorial drawings are three dimensional drawings. In spite of its advantage, pictorial drawing has the following limitations as compared to a multi-view drawing:

- ✓ it frequently has a distorted and unreal appearance of object being represented,
- ✓ relatively required more time to prepare pictorial representation of an object,
- ✓ it is difficult to measure and to give dimensions.

Due to these limitations, pictorial drawings are commonly used for technical illustrations, pipe diagrams, patent office records, and architectural drawings, to supplement multi-view orthographic drawings.

**Activity 7.1**

1. **Form a group and discuss about projection of a picture drawn or captured with a camera.**
2. **State some points on the real object which is three dimensional and how it appeared looking as a three dimension on a plane.**
3. **Observe the direction of the lines found on the picture and illustrate to other groups.**

### 7.1.1 Theory of Projection

The term 'projection' can be defined as the representation of an object on a picture planes as it would appear to an observer stationary at a point and viewing along the direction of projection. Hence, in order to carry out the process of projection, five major constituting elements should be fulfilled:

A. an *object* to be projected,

B. an *observer* who is viewing the object,

C. a *station point* where the observer is located,

D. *projection rays* or *projectors* emitting from the observer to the picture plane, and

E. *a plane of projection* or *picture plane* on which the projection is made.

The final outcome of the process of projection is an image of the object fixed on to the projection plane, which is usually termed as a *view* of the object.

Depending on the position of the observer relative to the object, projection can be categorized into two broad groups namely:

*central or perspective projection* and *parallel projection*.

**I. *Central or perspective projection:*** is a type of projection made on a picture plane in such a way that an observer is located at a finite (fixed distance) from the object being projected; therefore the projectors would converge to a point called *station point* or *point of sight* of an observer as illustrated in Fig. 7.1.

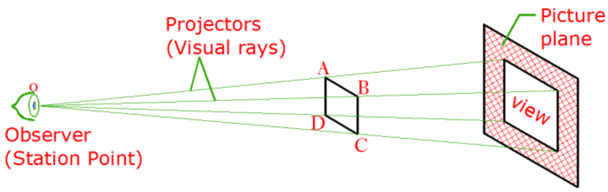



*Fig. 7.1 Principle of central projection*

In perspective projection, the perspective view formed on the picture plane is of a different size and shape as compared to the actual object.

**II. *Parallel projection:*** is a type of projection made on a picture plane in such a way that an observer is located at an infinite distance from the object being projected, therefore the projectors will be parallel to each other (see Fig. 7.2).

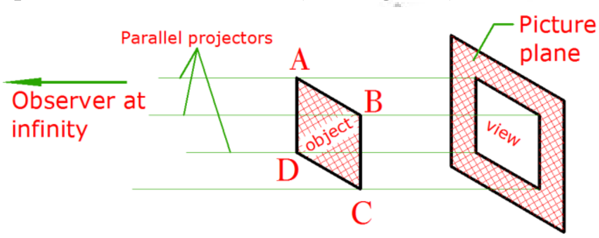



*Fig. 7.2 Principle of parallel projections*

In parallel projection, the view formed on the picture plane is of the same size and shape as that of the object. This will simplify transferring of linear and angular measurements of an object during projection. Parallel projection can be further divided into two groups depending on the angle formed between projectors and picture plane. These are:

A. Oblique projection, and
B. Orthographic projection.

**A. *Oblique projection:*** is a type of parallel projection obtained in such a way that the projection lines are made to be oblique or at an angle other than 90° to the picture plane. Hence the three principal faces of the object will be seen on a single picture plane.

**B. *Orthographic projection:*** is a type of parallel projection obtained in such a way that the projection lines are made to be perpendicular or at an angle of $90^0$ to the picture plane. Hence only one principal face of the object will be seen on the picture plane. For the detailed discussion refer unit 6 multi-view drawing. The term "*Orthographic*" is derived from words "*Ortho*" and "*graphics*" to mean "*Draw at right angle.*"

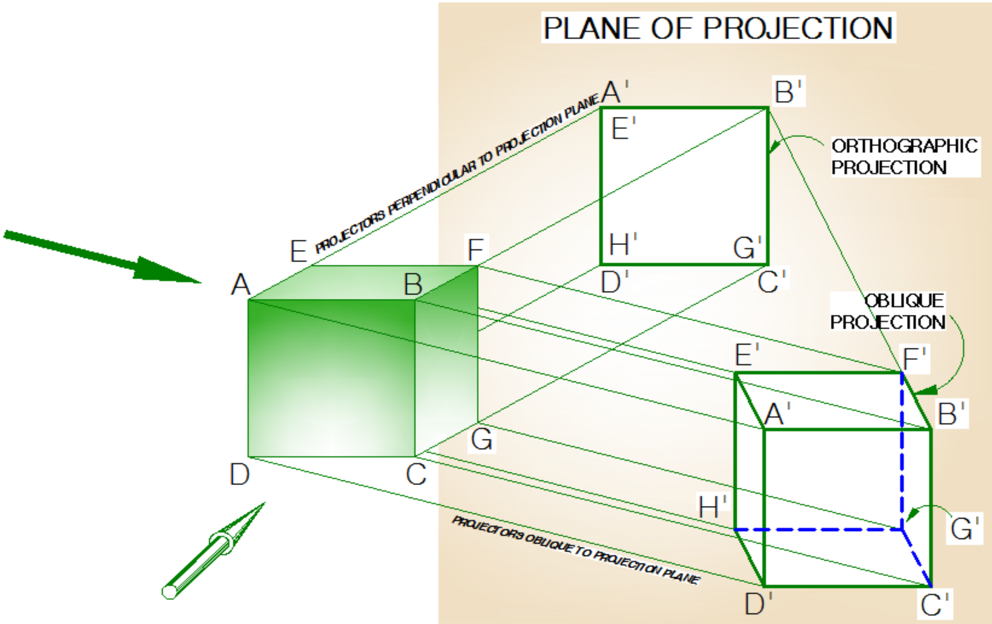



*Fig. 7.3 Principle of oblique and orthographic projections*

As shown in Fig.7.3, orthographic view provides the projection of only the front or rear face of the cube while oblique projection shows the three principal faces. In order to fully describe the principal faces of an object using orthographic projection, two methods can be employed. Either the object should be projected onto additional picture planes (as in the cases of multi-view projection), or it should be rotated and tilted about the picture plane so that all the three principal faces will be inclined (as in the case of axonometric representation).

In orthographic projection, if the edges of the cube, however, are inclined to the picture plane the projection is referred to as axonometric projection. To do so the cube is first rotated about a vertical axis and tilted backward as shown in Fig.7.4 until the three principal faces are visible to an observer.

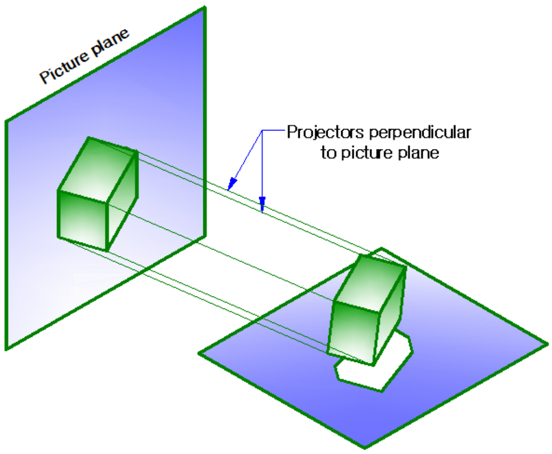



*Fig. 7.4 Principle of axonometric projection*

Considering the angle of inclinations of the edges of a cube with respect to the projection plane, axonometric projections may be classified into three categories as isometric projection, diametric projection and trimetric projection, which will be discussed in section 7.2.1.

The detail of these projection systems is presented in the subsequent sections of this chapter. In general classification hierarchy of projection can be summarized by using a projection tree shown in Fig.7.5.

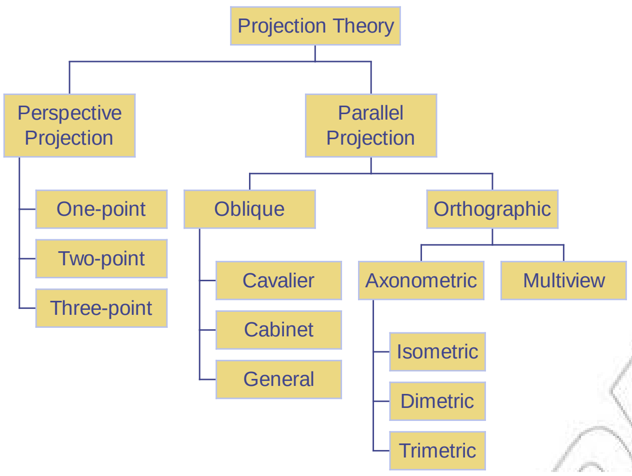



*Fig. 7.5 Projection tree*

## Checkpoint 7.1

1. **What is projection? What constitu-ting elements should be fulfilled to undertake projection?**
2. **What are the two broad categories of projection? Briefly explain the difference between them.**
3. **Describe the basic similarity and difference between orthographic and oblique projections.**

## 7.1.2 Types of Pictorial Drawing

Pictorial drawing, as discussed earlier, is a means by which the three principal faces and dimensions of an object are represented on a single 2D projection plane (sheet of paper). Pictorial drawing is divided into three classifications:

i. Axonometric projection,
ii. Oblique projection, and
iii. Perspective or central projection.

The difference among the three projection types is illustrated pictorially as shown in Fig. 7.6.

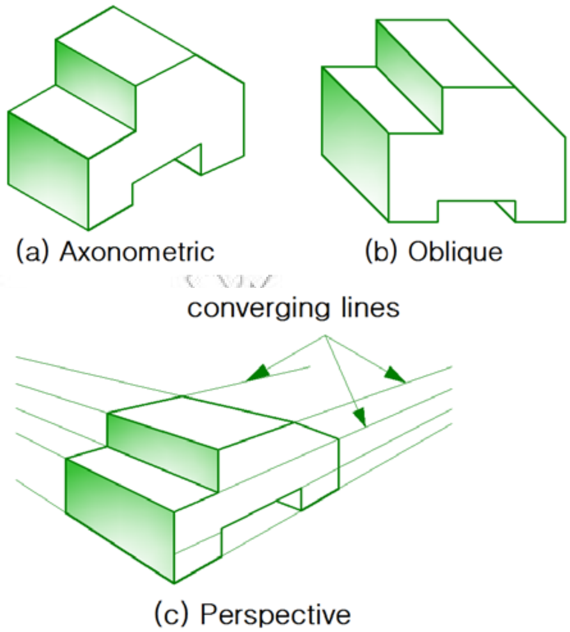



*Fig. 7.6 Axonometric, oblique and perspective projections*

**Checkpoint 7.2**

1. **What are the main purposes of pictorial representation? What limitations does it have when compared to multi-view representation?**
2. **Briefly describe the three types of pictorial representations.**

## 7.2 Axonometric Projection

It is a form of orthographic projection that shows the three principal faces of an object on a single projection plane (picture plane) unlike multi-view projection which uses three different projection planes for the three principal faces. In axonometric projection, the object is placed in an inclined position with respect to the plane of projection so that its principal faces will be displayed principally in axonometric projection.

The following three steps should be considered in placing the object when trying to display the axonometric projection of an object on a picture plane as shown in Fig 7.7.

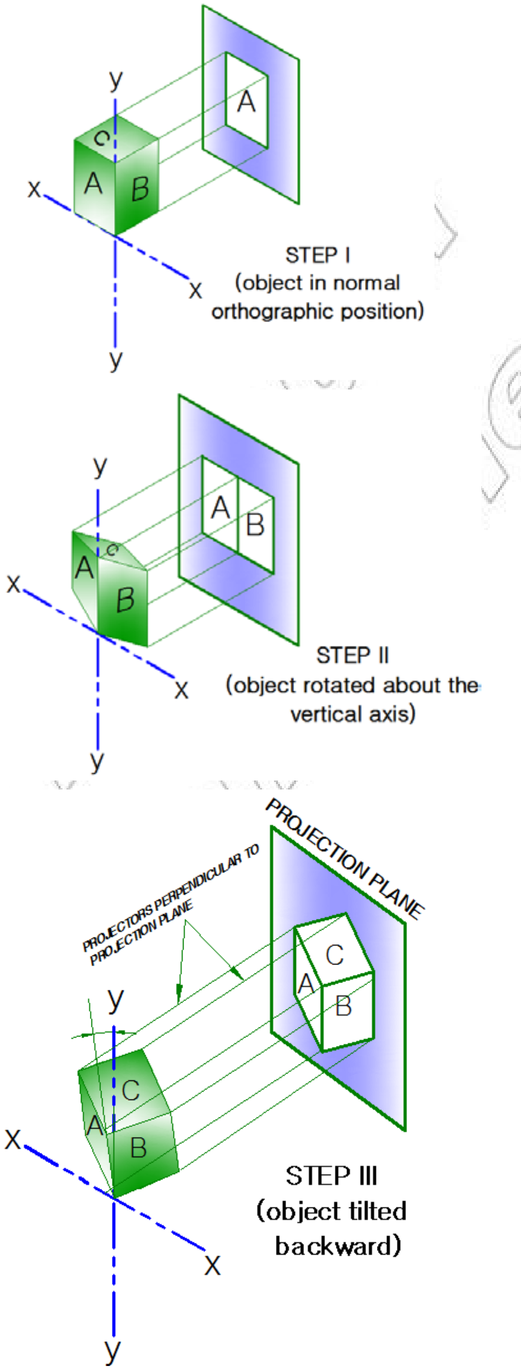



*Fig. 7.7 Theory of axonometric projection*

**Step1:** The object is first placed in its customary position, with one principal face made parallel to the picture plane.

**Step2:** It is then rotated from its ordinary position about the vertical axis through any proper angle so as to display the two lateral faces on the projection.

**Step3:** Finally the object is tilted forward or back ward through again any desired angle so as to display the third face i.e. top or bottom and then projected on the picture plane.

### 7.2.1 Types of Axonometric Projection

1. **What do you understand from the words isometric, diametric and trimetric literally?**
2. **from your sketch of a box, observe the angle between the lines. Are they identical or have the same angles or does it differs?**

An object may be placed in an infinite number of positions relative to the projection plane. As a result, a countless number of views of an object may be formed which will vary in proportions and shape. For practical reasons in pictorial drawing, three possible positions have been identified as division of axonometric projection:

i. Isometric Projection
ii. Dimetric Projection
iii. Trimetric Projection

### *I. Isometric Projection:*

Literally the term "*isometric*" is a combination of two words "*iso*" and "*metric*" which means '*equal measures*'. It is the simplest and most popular type of axonometric projection, because the three principal edges of a cube make equal angles with the projection plane, and hence will be foreshortened equally on the isometric projection. These principal edges are usually referred to as *isometric axis*.

In isometric projection, an object is rotated through 45° angle about a vertical axis, and then tilted backward with an angle of $35^0 16'$ from the top face. In this case, the three isometric axes will make an angle of approximately $35^0 16'$ with the vertical plane of projection. The projections of these axises will make an angle of $120^0$ with respect to each other. The projected length of the principal edges of an object are approximately 81.6% or 82% or 0.82 of their true length.

In order to make an isometric projection of a cube of known side length, there are two alternative methods.

A. By turning and tilting the object in relation of a given projection plane as shown on Fig.7.8.

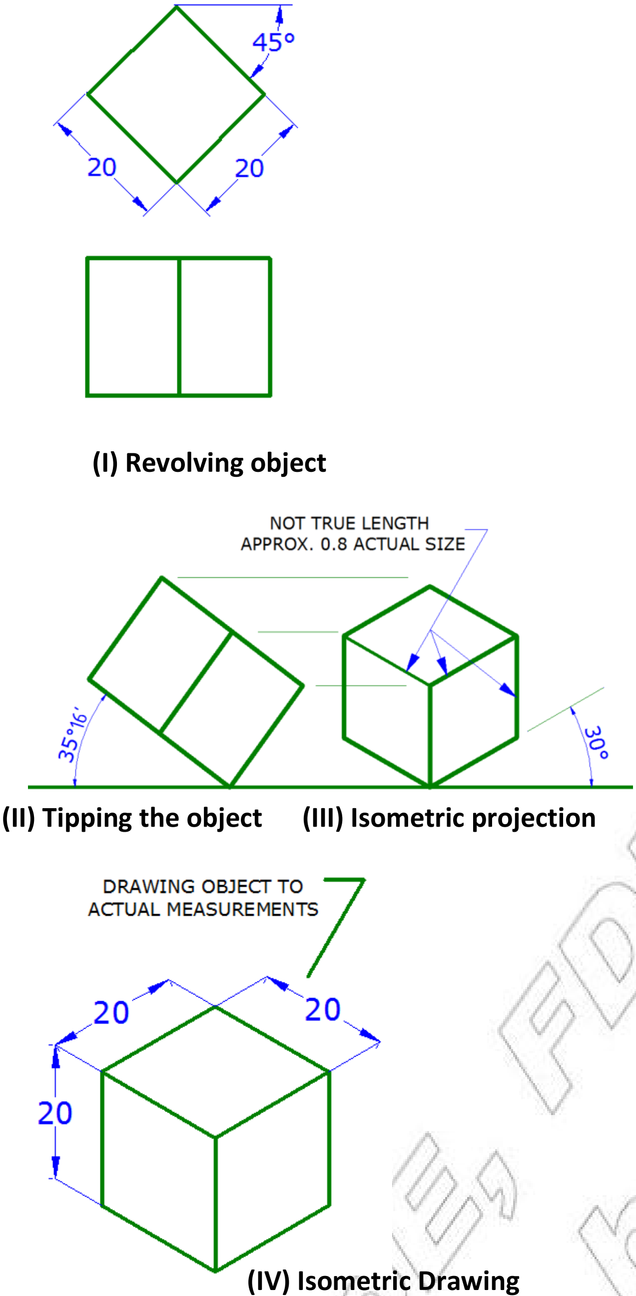



*Fig. 7.8 Isometric projection*

B. By turning the plane till it is made perpendicular to the body diagonal or using primary and secondary auxiliary view.

The foreshortening of edges will lead us to the problem of selection of isometric scale which is a special measurement scale which can be prepared on a strip of paper or cardboard.

## *Construction of Isometric Scale Length*

Draw a horizontal line of any defined length. At the left end of the line draw another line at angles of $30^0$ to represent the isometric length measured from isometric scale and at an angle of $45^0$ to represent the true length measured from ordinary scale. Mark any required number of divisions on the true length line. From each division points of true length line draw vertical lines perpendicular to the initial horizontal line so as to get intersection points on the isometric length line representing corresponding points.

The divisions thus obtained on the isometric length give the different lengths on isometric scale. The isometric drawing obtained by using the true lengths will be exactly of the same shape but larger in proportion than that obtained by using the isometric lengths.

The view draw with the use of ordinary scale is called isometric drawing while that drawn with the use of isometric scale is called *isometric projection*.

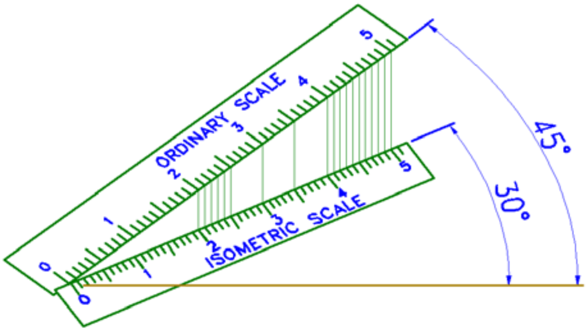
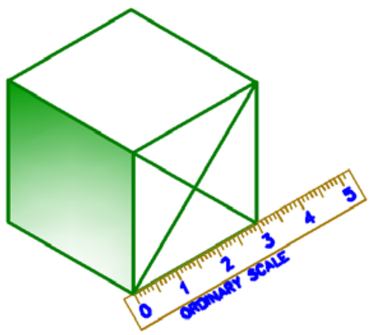
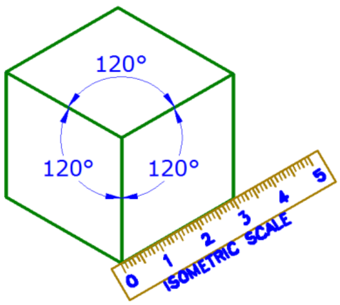



*Fig. 7.9 Isometric scale*

In using the isometric scales actual length of an edge is first measured by an ordinary scale from an object and the same reading will be laid off along the isometric axis with the help of the isometric scale.




**a) Given object (Measured by Normal-scale)**



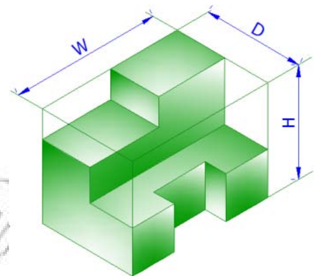

**b) Isometric Projection (Measured by Isometric-scale)**

*Fig. 7.10 Using the isometric Scale*

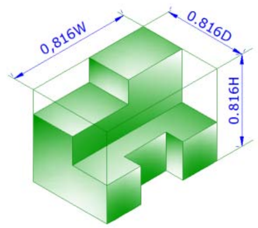
Therefore isometric pictorials are generally divided into two:

**A. *Isometric projection:*** is a type of axonometric projection having parallel projectors that are perpendicular to the picture plane. With this projection, the diagonals of a cube appear as a point. The three axes are spaced $120^0$ a part and the sides are for shortened 82% of their true length.

**B. *Isometric drawing:*** is the same as isometric projection except the sides are drawn in true length. This makes it appear like the isometric projection. It is not a true axonometric projection but produces an approximate view. Usually it is prepared by transferring actual or true length of the object along isometric axes using ordinary scale. Fig.7.11 compares the isometric projection with isometric drawing.




**a) Isometric drawing**




**b) Isometric projection**

*Fig. 7.11 Isometric drawing and isometric projection*

In general practice to represent an object pictorially, isometric drawing is used for its ease of construction simply by taking true length dimensions directly from the orthographic view of the object.

### II. Dimetric Projection

It is a form of axonometric projection in which two scales of measurements are used. The same scale is used along two axes but a different one is used along the third axis. Two of the axes make equal angles with the plane of projection while the third axis makes a different angle with the plane. As a result, the two axis making equal angles are equally foreshortened, while the third axis is foreshortened in a different ratio. In practice dimetric projection has very little application due to the difficulties in transferring measurements with various scales. Since two different scales are used, less distortion is apparent than isometric drawing.

In dimetric drawing, the angles formed by the receding axes and their scales are many and varied. Fig.7.12 shows some of the more generally used positions of axes and scales. These scales and angles are approximate.

Dimetric templates and grid papers are available to aid in the construction of diametric drawing, where the templates have appropriate scales.

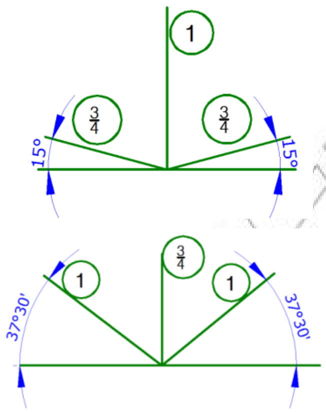



*Fig. 7.12 Scale and axes commonly used in dimetric drawing*

### III. Trimetric Projection

It is a form of axonometric projection in which different scales are used to lay off measurement and all the three axes are differently foreshortened. The object is so placed that all the three faces and axes make different angle with the plane of projection.

The advantage of trimetric drawing is that they have less distortion than diametric and isometric drawing. Dimetric and trimetric projections have little practical applications as compared to isometric projections. Fig.7.13 shows isometric, diametric, and trimetric projections.

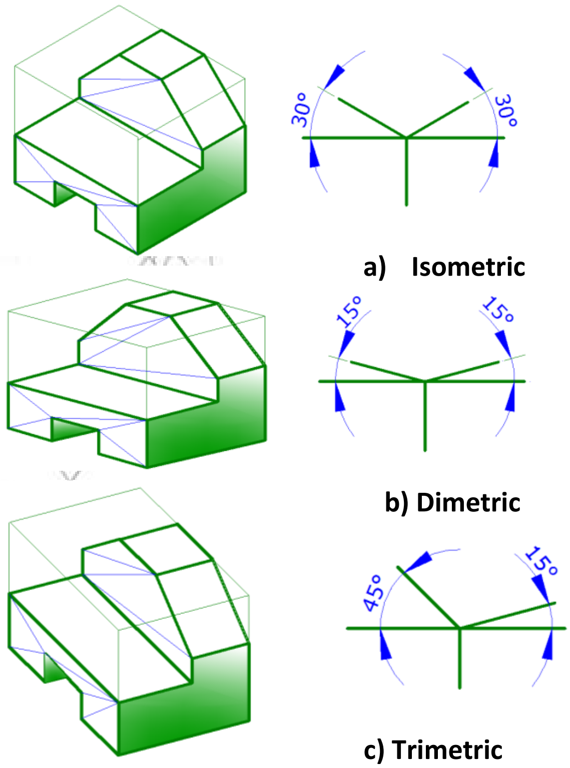



*Fig. 7.13 Alternative positions of an axonometric projection*

### 7.2.2 Alternate Position of Isometric Axes

The three front edges of the enclosing box, shown in Fig.7.14, are referred to as isometric axes. In an isometric drawing of a simple rectangular object, the isometric axes are first drawn at an angle of $120^0$ with each other. The two receding axes along which the width and depth dimension are transferred are drawn at an angle of $30^0$ with a horizontal line drawn through the intersection point of the axes. These isometric axes may be placed in any one of the four alternative positions as shown in Fig.7.14. However, the angles between the adjacent axes must remain $120^o$.

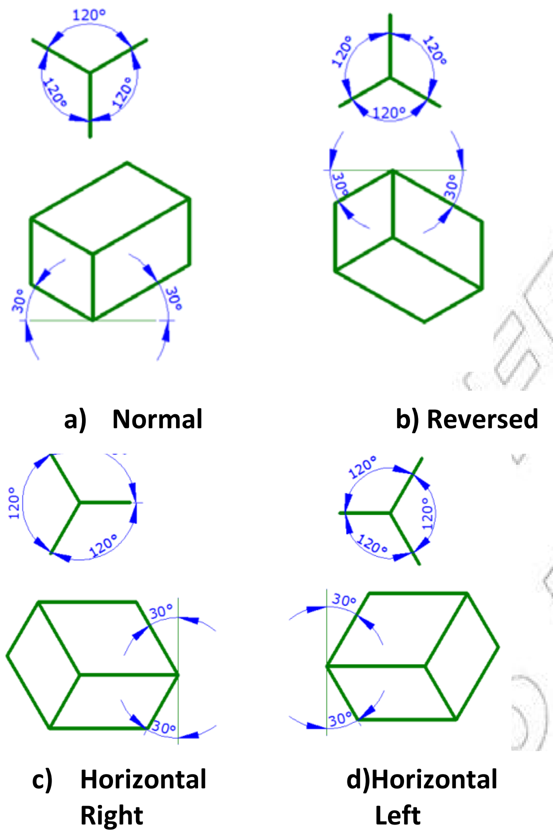



*Fig. 7.14 Alternative Positions of Isometric Axes.*

The choice of the position of the axes is determined by the position from which the object is usually viewed, or by the position which best describes the shapes of the object. If an object is characterized by proportional depth, width and height the normal position of the axes shown by choice Fig.7.14 (a) is most appropriate. However, if the natural viewing direction is from below then choice (b) would be appropriate. In the case of a long slender object, which has a considerable width as compared to its depth and height, the choice (c) and (d) would give the best effect.

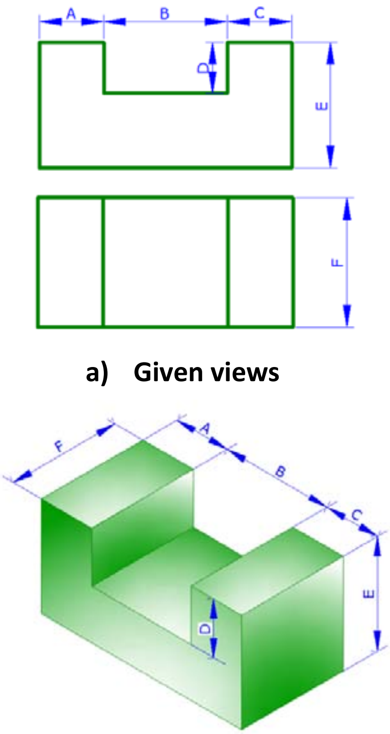
**Activity 7.2**

1. **Sketch a cube having an inclined plane or trim one of the cube's edge and observe how the direction of the line goes to represent the inclined plane.**
2. **Form a group and discuss with your friends how to represent an object which has a circle or an irregular curve on it. Use sketch to illustrate this.**

### 7.2.3 Lines and Angles in Isometric Drawing

***Isometric and non-isometric lines***

***Isometric lines*** are edges of an object whose positions are parallel to the isometric axes. In an isometric drawing, isometric lines are laid off with full scale along the directions of the isometric axes by transferring the actual lengths directly from the orthographic views on to the isometric drawing. For the object shown in Fig.7.15, the edges that define its characteristic shape are all isometric lines. Hence, their actual lengths are transferred directely from the orthographic views to the isometric drawing.




a) Given views

b) Isometric view

*Fig. 7.15 Constructing Isometric Edges*

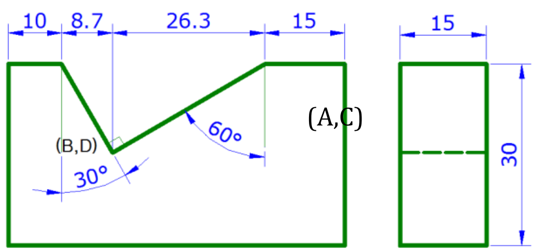
***Non-isometric lines*** are those lines or edges of an object which are inclined and are not parallel to the isometric axes. Such a line doesn't appear in its true length and cannot be measured directly in the isometric drawing. Its position and projected length is established by locating its starting and ending terminal points on the isometric axes. For the object shown in Fig.7.16 edges *AB* and *CD* of the included surface *ABCD* are non-isometric lines. These lines cannot be directly transferred from the orthographic view to the isometric drawing. The location of the inclined line *AB* is determined by locating the end points *A* and *B* on their respective isometric edges. Point *A* must be located on the top edge, *15* units distance from the top-right corner; and point *B* is located on the front face, *15.2* units below the upper edge and *18.7* units from the left edge. Then, connect *A* and *B* to get the projection of edge *AB* on the isometric drawing. Follow similar steps to lay off edge *CD*. Notice that line *AB* on the isometric drawing is of different length as compared to its actual length shown in the orthographic view.

Note that hidden lines are usually not used in any form of pictorial drawing. To show all edges which are not visible would make the drawing difficult to read. In some cases however, hidden lines may be used to show a feature of the object which is not visible.

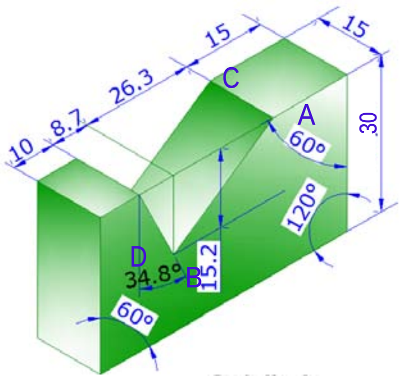
### *Angles in isometric drawing*

The isometric axes are mutually perpendicular in space. However, in an isometric drawing they will appear at $120^0$ to each other. As a matter of fact, angular measurements of an object specified in orthographic views do not appear in their true sizes in an isometric drawing. These angles cannot be measured in degrees with an ordinary protractor. Special isometric protractors are available for laying off angles in isometric. If an isometric protractor is not available, all angular measurements must be converted to linear measurements, in a manner which can be laid off along isometric lines in a pictorial drawing. To locate an inclined edge of an object that has been specified by an angular dimension, usually one or more linear measurements are taken from an orthographic view and set off along isometric lines.

Fig.7.16 shows again isometric constraction of an object with angles using distance transfer method along isomertic axes. Notice that none of the interior angles of a plane in its orthographic representation will be projected in the same size in the isometric drawing. Since the shape of a surface will be distorted when projected onto an isometric plane, angles cannot be setoff directly in isometric drawing. It is necessary to locate the end points of the lines which subtend the angles using linear measurements as illustrated in the figure.




**a) Given views**




**b) Isometric view**

*Fig. 7.16 Isometric construction of non-isometric edges*

## 7.2.4 Regular and Irregular Curves in Isometric Drawing.

### *Circles and Arcs in Isometric Drawing*

Many objects involve circles and other curves in their construction. In Isometric projection, a circle will appear as an ellipse. This ellipse is usually called as *isometric circle*. The true or accurate ellipse can be constructed by means of a series of offset measurement as shown in Fig.7.17. To begin with; required numbers of points are established on the circumference of the circle either by dividing it into equal number of parts or assuming random spacing.

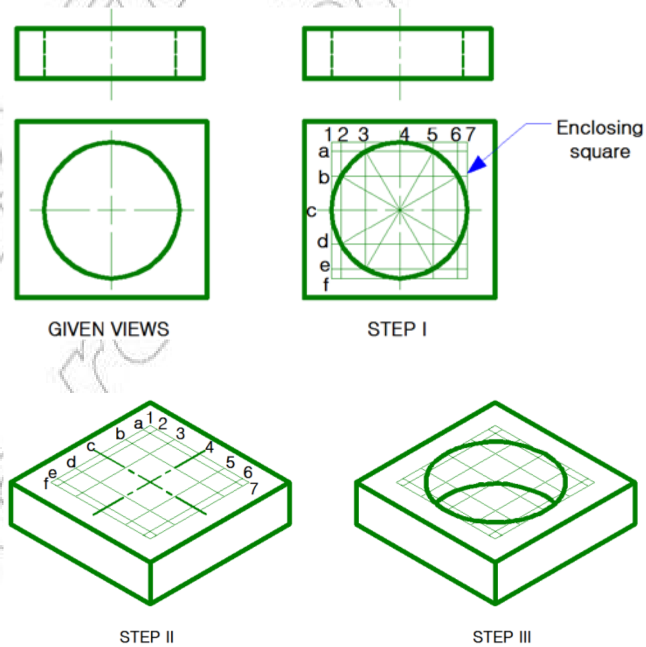



*Fig. 7.17 Constriction of isometric circles by offset measurement*

As shown in step-I of fig 7.17, the points a, b, c,... on the circumference of the circle are choosen at random spacing. In the isometric drawing, point A is located by transferring the offset measurements with respect to the isometric edges. In a similar manner, all other points are located by offset measurements. Finally draw smooth curve that connects all the points located using French curve so as to represent the isometric circle (ellipse) of the object; however this method of ellipse construction is tedious and time consuming. Therefore now a day for most practical purpose another approximate method called *four center method* is used. In this method of ellipse construction a square is conceived to be circumscribed about the circle in the orthographic projection. This square will be distorted and becomes a rhombus (isometric-square) which becomes tangent to the ellipse at the midpoints of its sides. The two corners at the larger angle of the rhombus are used as two of the four centers to draw the larger arcs of the ellipse. The intersection points of the perpendicular bisectors of the sides of the rhombus laying inside the rhombus will be the remaining two centers for the two smaller arcs to complete the ellipse.

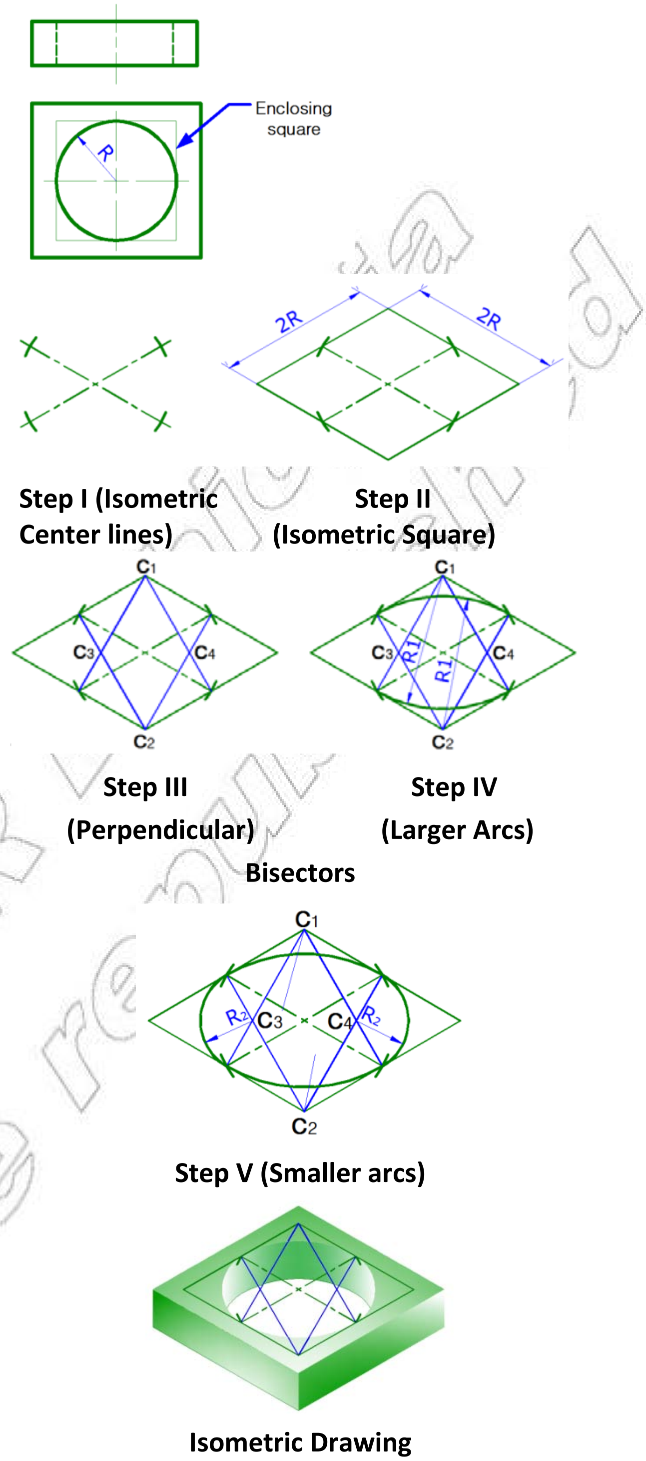



*Fig. 7.18 Construction of isometric circle using four center method*

*These steps will be summarized as follows:*

**Step I.** Locate the postion of the center point, O, of the circle on the isometric plane and constract the isometric center lines of the circle with light lines plarallel to the isometric edges. Using a radius, R, which is equal to the radius of the circle in the orthographic view, strike arcs across the isometric center-lines.

**Step II.** Complete the rhombus, whose side lengths are equal to the diameter of the given circle, by drawing light line through the intersections of the four arcs and the center lines.

**Step III.** Erect perpendicular bisectors to each sides of the rhombus. These perpendiculars will pass through the the opposite corners of the rhombus. Identify the four interssection points $C_1$, $C_2$, $C_3$, and $C_4$ of the perpendiculars, which are assumed to be center points of the approximating arcs to be shown.

**Step IV.** Use $C_1$ and $C_2$ as centers and the length from these centers to the midpoint of the opposite sides ($r_1$) as a radius, draw the two larger arcs of the ellipse.

**Step V.** In a similar manner, use $C_3$ and $C_4$ as centers and the length from these centers to the midpoint of the near sides of the rhombus ($r_2$) as a radius, draw the remaining two smaller arcs to complete the approximate ellipse.

In isometric drawing circular arcs (incomplete circles) will be represented as incomplete ellipse drawn with the same procedure and principle using four center method. For quarter and semi circle it will be sufficient to use one and two centers respectively.

Concentric circles in an isometric drawing will share one central point and the same center lines (see Fig.7.19). To draw isometric concentric circles, two sets of approximating centers are located. The first sets of four centers are used to construct the external ellipse and the second set of four centers for the inner ellipse. All the other procedures to establish the four centers for both ellipses are the same except the circular size difference in isometric plane.

When circles and arcs are to be drawn on parallel planes, the four centers can be moved along the isometric axes. The same radii can be used to draw the arc or circle on the parallel plane.

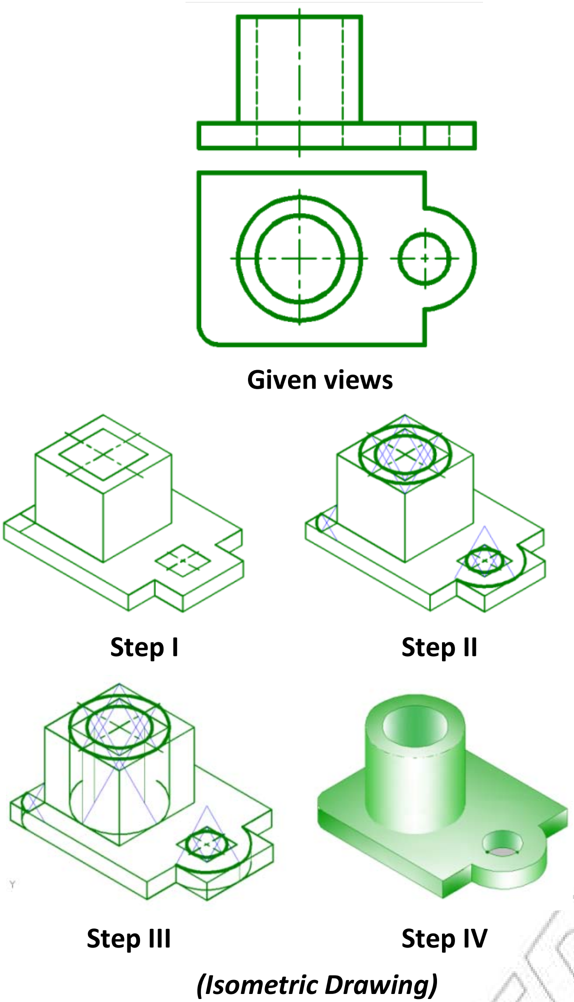



*Fig. 7.19 Isometric circles and arcs on parallel planes*

In general, two types of common mistakes are frequently committed by students in making isometric circles and arcs on isometric drawings. The first error is drawing the isometric circle out of the proper isometric plane. This mistake can be resolved by initially drawing the four sides of the enclosing rhombus of the ellipse parallel to the edge of the isometric planes on which the ellipse are drawn. The second error is failing to put tangent lines between parallel arcs and circles to show the depth (thickness) of a cylindrical part. These shortcomings are illustrated by Fig. 7.20.

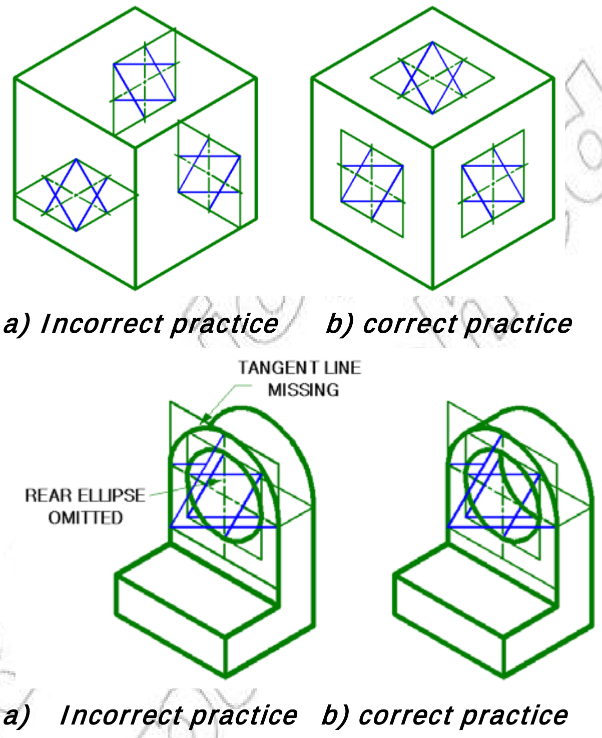



*Fig. 7.20 Representation of thickness in isometric drawing*

### Irregular curves in isometric drawing

An irregular curve is drawn in isometric by means of a series of offset measurements discussed earlier in the construction of true ellipse. See Fig. 7.21.

Any desired numbers of points are randomly selected along the curve in the given views. The number of points should be sufficient enough to construct the curve accurately. Offset grid lines are then drawn from each point parallel to the principal edges of the plane. These offset measurements are laid off on the isometric plane to locate all points on the irregular curve as in step-II.

The parallel curve is drawn by moving the points parallel to the isometric axes through these points a distance equal to the thickness of the curved part. The final solid curve is drawn by using French curve as shown in step-III.

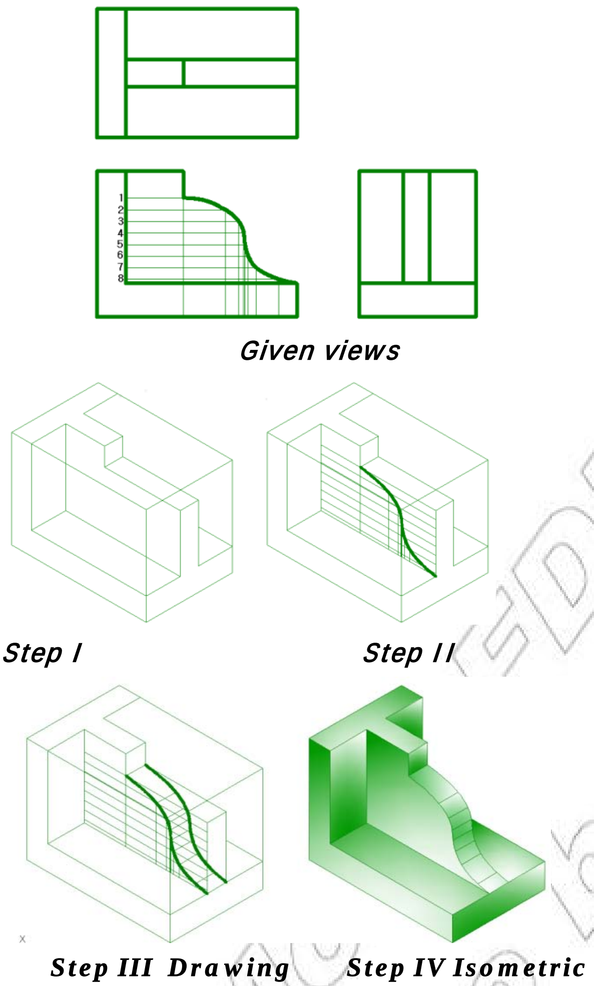



*Fig. 7.21 Curves in isometric drawing*

## Offset location Measurement

In a complex object there may be parts which are protruded or else removed from the main block. The positions of such extrusion of cut offs are located by using offset measurements. This method is shown in Fig.7.22.

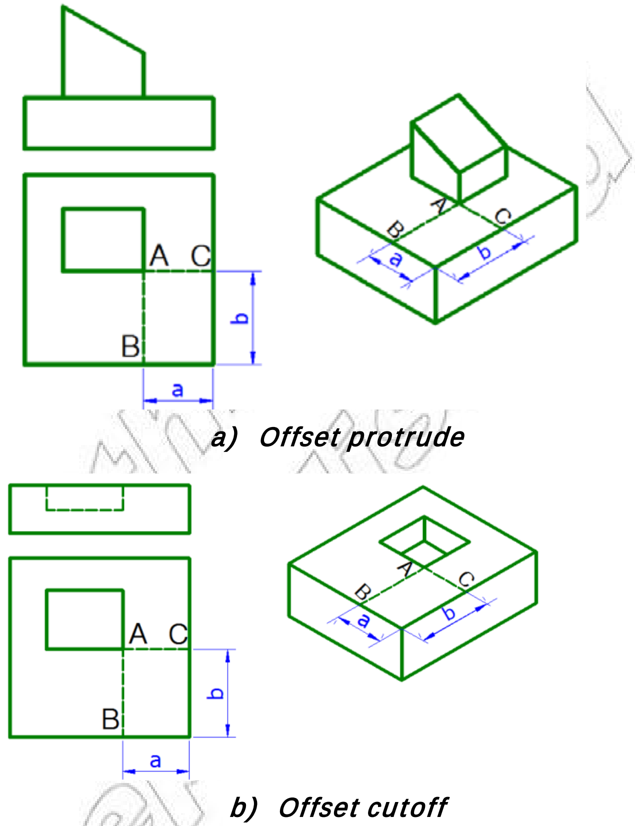



*Fig. 7.22 Offset Location measurements in isometric drawing*

As shown in the above two cases, initially the basement boxes have been drawn to full scale. Then the offset lines AB and AC in the multi-view orthographic projections are transferred to the main blocks to locate point A in both cases. These measurements are referred to as *offset measurements*, and they are measured parallel to the isometric axes. Taking point A as reference, the rectangular wedge shown in *case (a)* or the rectangular hole shown in *case (b)* is drawn with the same scale.

## 7.2.5 Isometric Construction

There are two methods of isometric construction:

1. Box method, and
2. Centerline lay out method

### *1. Box Method*

In this method of isometric construction, the object is assumed to be fully enclosed within an isometric box whose sides coincide with the overall dimensions of the object.

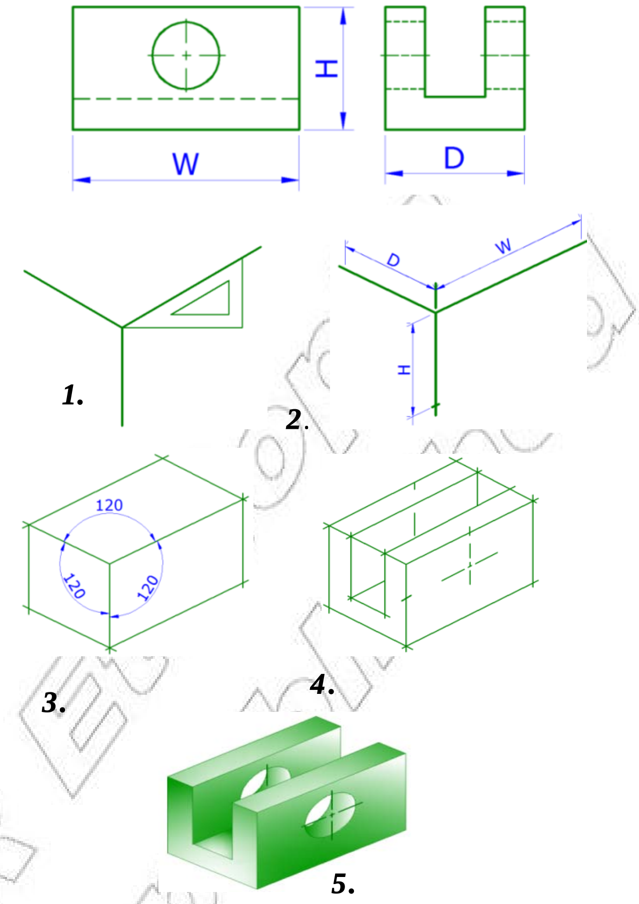


*Fig. 7.23 Construction of isometric drawing*

### *Making Isometric Drawing*

To make isometric drawing, choose the position of the axes that will best show the object or the sides that is most important. The following steps are used to make an isometric drawing from the given orthographic views as shown on Fig.7.23.

**Step I.** Lay out the isometric axes in any required position at 120° a part.

**Step II.** Transfer the overall dimensions i.e. Height, width, and depth from the orthographic view along the isometric axes accordingly so as to have a block in the size of the object.

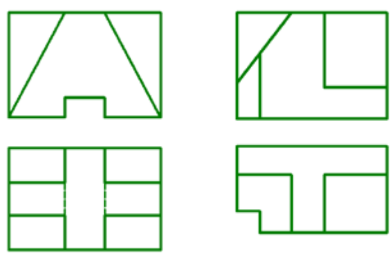
**Step III.** Draw the isometric box, with light constraction line in which the object is contained.

**Step IV.** Locate the other features by transferring dimensions along the corresponding isometric axes or lines drawn parallel to isometric axes from the orthographic views.

**Step V.** Complete the isometric drawing of the object.

**Checkpoint 7.3**

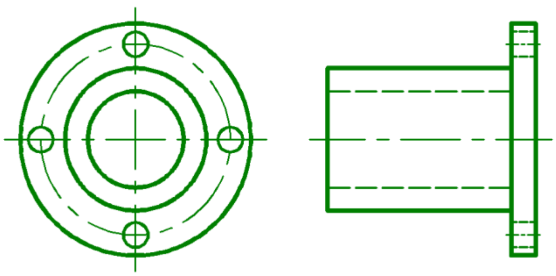
**Make an isometric drawing for the orthographic views given below using box method of isometric construction.**



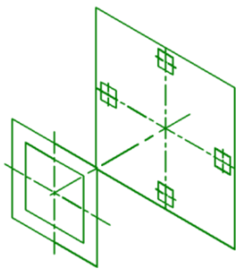
## 2. Centerline Layout Method

When the object is cylindrical in nature with a number of circular features lying in the same or parallel planes, the *centerline layout method* is more convenient for rapid construction. The steps to be followed in making the isometric drawing of a typical object using this method is shown in Fig.7.24.

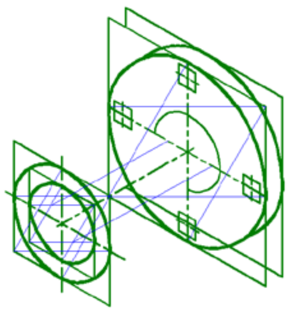
As described in the figure, the first step is to draw the isometric layout of the principal center lines for the given object. Isometric circles on visible planes are then constructed by the four center method. Cylindrical parts are then completed by adding tangents to circles on parallel planes. Portion of rear ellipses should be drawn to specify depths of small circular holes.



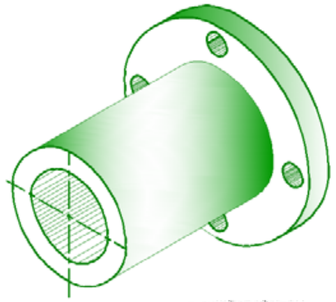
**Orthographic Views (Given)**



*Step I*



*Step II*

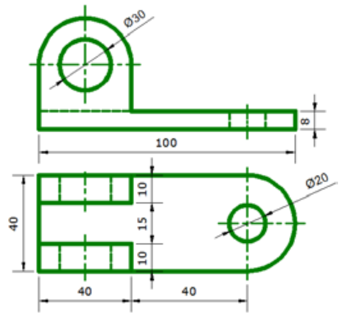


***Step III***
***(Isometric drawing)***

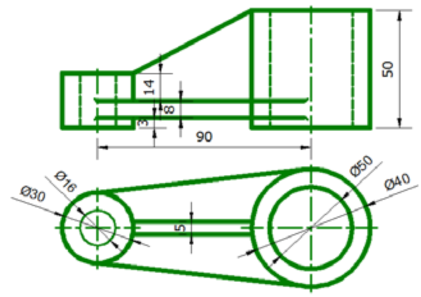
*Fig. 7.24 Isometric construction by centerline layout method*

### Checkpoint 7.4

**Make the isometric drawing of the following object using center line layout method.**




**a)**




**b)**

## 7.3 Oblique Projection

- **Sketch the front view of a cube and extend 30-45° lines from its edges and repeat the front view at a position where the extension line you just made ends. What did you observe from the pictorial drawing you get from your sketch?**

This method of pictorial drawing is based on the procedure of placing the object with one face parallel to frontal plane and placing the other two faces on the receding planes to left (right), top (bottom) at a convenient angle commonly at $45^0$. The face of the object made parallel to the frontal plane will appear as true size and shape. It is the easiest type to make pictorial drawing of an object and have the following advantage over other type of pictorial drawing:

- ✓ Distortion will be minimized by placing the longest dimension of the object parallel to the frontal plane of projection.
- ✓ Construction of pictorial drawing of an object will be simplified by placing the face with greatest number of circular outline and irregular outlines (contours) parallel to the frontal plane of projection. So that circular outline will be drawn as circle in its true shape by using compass (template) than drawing.

### *Principle of Oblique Projection*

In axonometric projection, the lines of sights (projectors) are assumed to be at a right angle to the picture plane. But, in oblique projection, the lines of sight are at an angle different from $90^0$ to the picture plane.

In both axonometric and oblique projections, the lines of sight are parallel to each other, i.e, the station point is assumed to be at infinity. Therefore, in both projection methods, a line that is parallel to the picture plane will project in its true length. Consequently, any face that is parallel to the picture plane will project in its true size and shape as shown in Fig. 7.25.

In this figure observe that both the orthographic and oblique projections of the front face ABCD are identical. They both represent the true size and shape of the front face. This is because the front face ABCD is parallel to the picture plane.

Unlike orthographic projection, for a given position of an object, it is possible to produce infinite number of oblique projections by simply changing the angle the lines of sight make with the picture plane. However, for practical reasons, only some standard angles like $30^0$, $45^0$ and $60^0$ are selected, but commonly a $45^0$ is used.

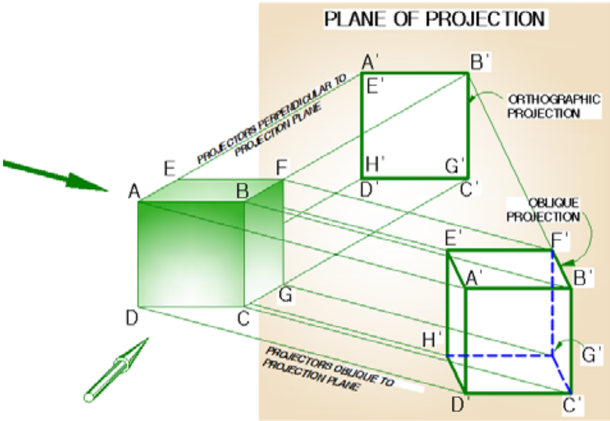



*Fig. 7.25 Pictorial representation of oblique projection*

### 7.3.1 Types of Oblique Drawing

Depending on the angle the lines of sight make with the picture plane and their extensive use, oblique drawing is generally classified as *cavalier*, *cabinet* and *general oblique*. The general oblique drawing is not discussed in detail because of its rare application.

**Cavalier Oblique drawing:** is a type of oblique drawing in which the same full scale is used along all the three axes.

**Cabinet Oblique drawing:** is the second type of oblique drawing in which the scale along the receding axis is reduced by one-half of that used on the front face to compensate for distortion and to approximate more closely what the human eye would see.

**General oblique drawing:** is a type of oblique drawing in which the scale along the receding axis is reduced between one half and full size e.g. three-fourth of the true length is commonly used.

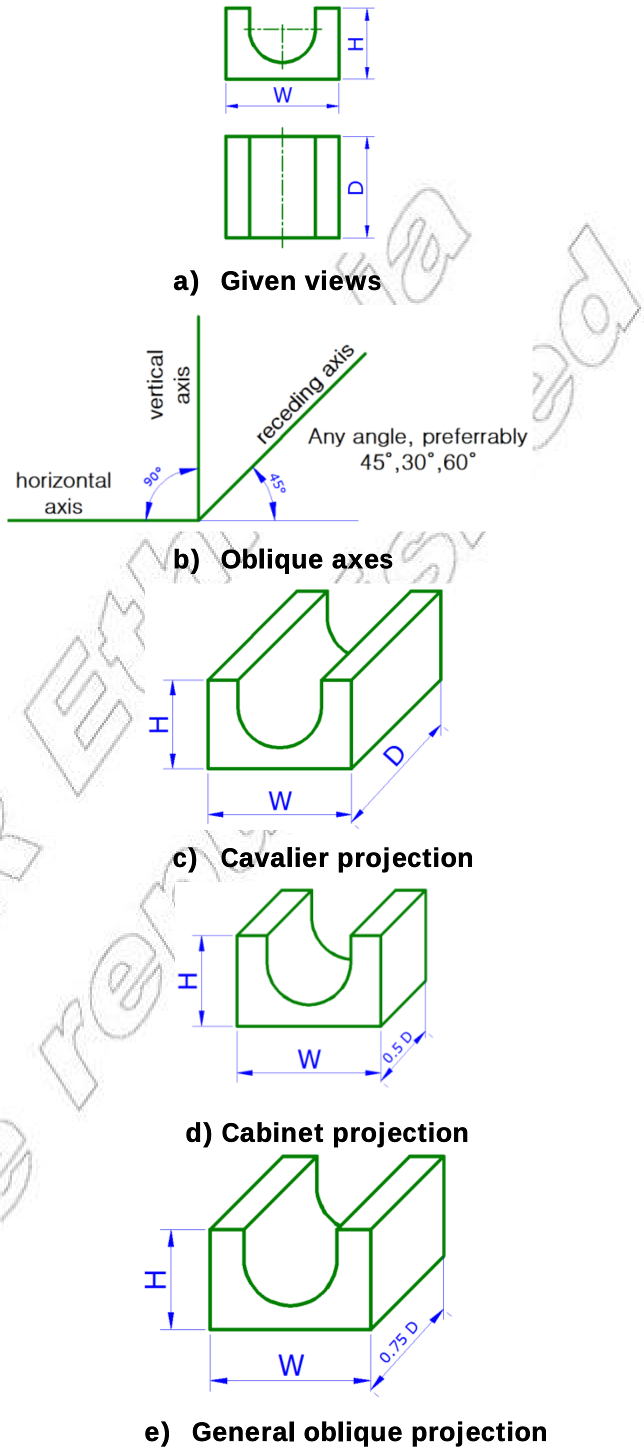



*Fig. 7.26 Types of oblique projection*

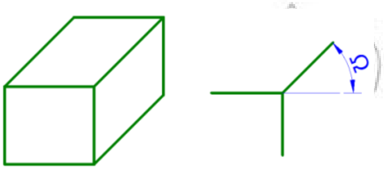
**Checkpoint 7.5**

1. What are the basic difference between oblique and axonometric projections?
2. What are the commonly used types of oblique drawing?

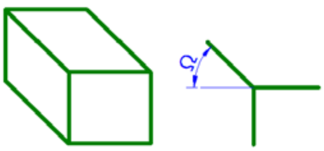
## 7.3.2 Position of Axes in Oblique Drawing

There are three axes of projections to be used in oblique drawing namely horizontal, verticals, receding axes. The horizontal, and verticals axes are arranged at right angle to each other, while the receding axis may be at any angle as shown in Fig.7.27, but commonly drawn at an angle of $30^0$, $45^0$ and $60^0$ as shown in Fig.7.27. However the angle that enables one to easily read and draw the details on the receding face will be selected. For example if a greater degree of detail appears on the top of the object the angle of the receding axis would be increased.

The three axes may be positioned differently based on the type of the object to be represented.

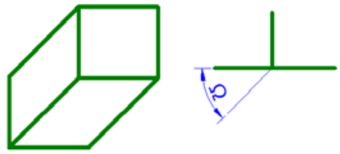


a)



b)

c)



d)

*Fig. 7.27 Alternate positions of axes in oblique drawing*

### *Choice of Position of the Object*

The general shape of the object will have some effect on its position. The most descriptive features of the object should be placed parallel to the plane of projection. This is very important when drawing a piece having circle, irregular curves and largest face (longest dimension) as mentioned earlier. The selection of the position for oblique representation of an object will be based on two main reasons.

### *To Simplify Construction*

To make the construction of oblique drawing easy and simple, the face of the object that has the most circles, arcs and other irregular curves should be placed parallel to frontal picture plane. Note that the object in Fig.7.28 (a) is easier to draw and yet looks much better than Fig. 7.28 (b).

a) Preferable b) More distorted

*Fig. 7.28 Oblique drawings of objects with circles on their front face*

The other method to reduce distortion in oblique drawing is to reduce the scale used on the receding axis as in cabinet drawings (see Fig.7.29) by placing the object with the longest face parallel to the frontal picture plane.

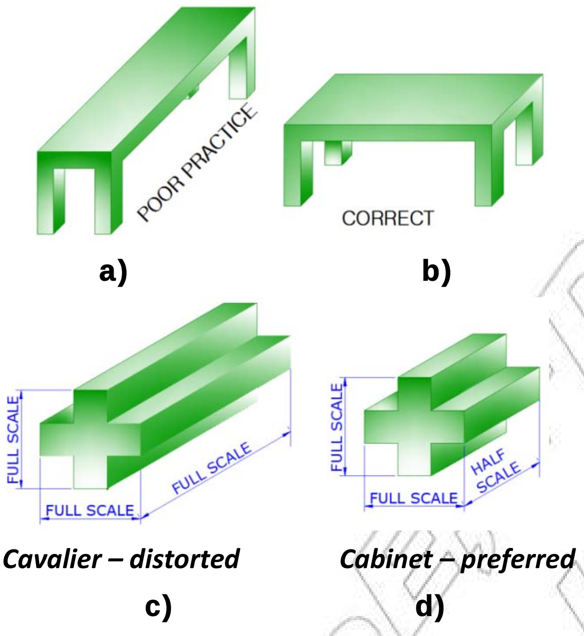



*Fig. 7.29 Long dimension of object parallel to picture plane*

## 7.3.3 Oblique Drawing Constriction

Like isometric drawings, oblique drawings can be constructed by using both the box construction method and centerline layout method.

### The Box Construction Method

The steps in making an oblique drawing of an object using the box method are the following: (See Fig.7.30)

**Step I.** Enclose the orthographic views of the object with square or rectangle using overall dimensions.

**Step II.** Determine about the position and face of the object to be brought to front based on the selection criteria for best oblique drawing representation discussed earlier.

**Step III.** Draw the oblique enclosing box with light construction lines using full, half and between half and full scale of the true length along the receding axis for cavalier, cabinet and general oblique drawing types respectively. Note that the receding axis should be at an angle that will show the side and top face to the best advantage.

**Step IV.** Draw all lines in the face parallel to the front face.

**Step V.** Draw the curves on receding face using offset measurement method.

**Step VI.** Complete all the lines and darken the necessary lines to finish the oblique drawing.

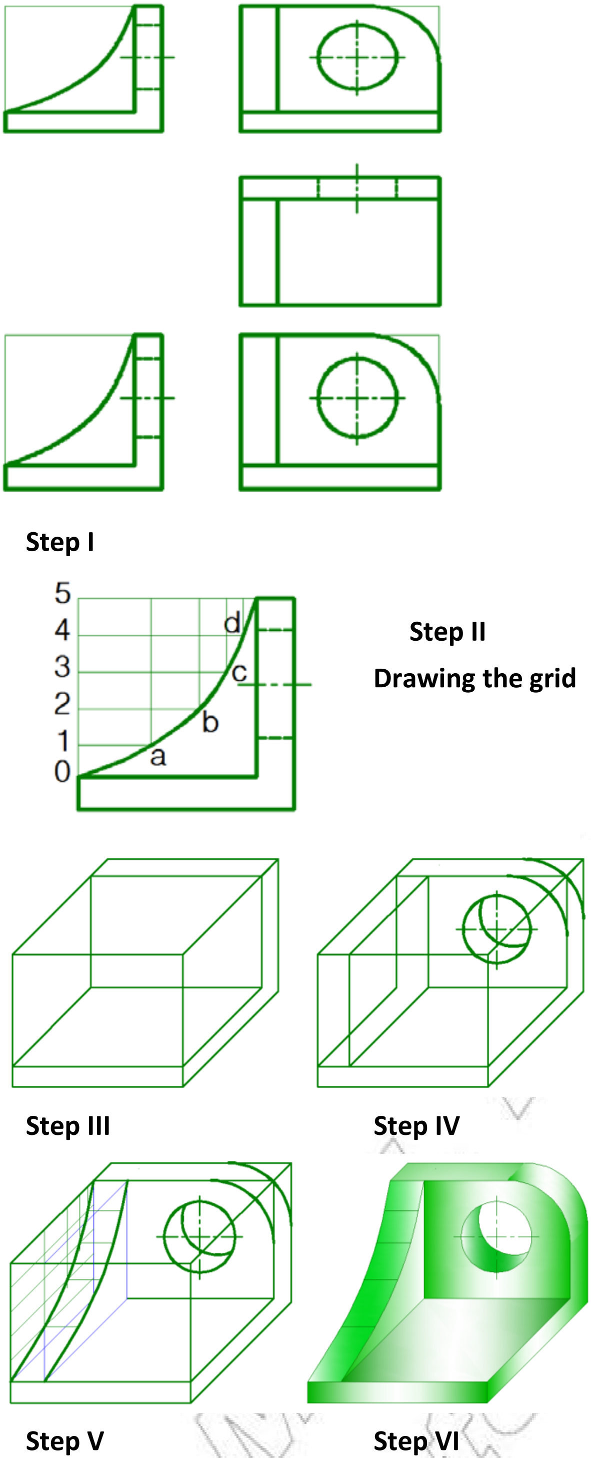
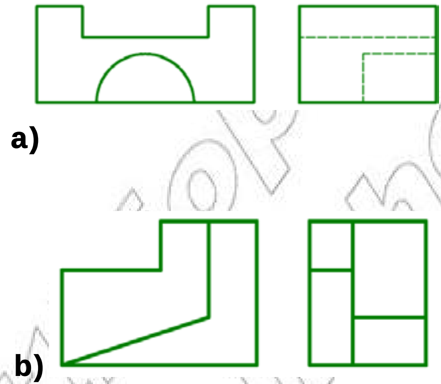



*Fig. 7.30 Construction of oblique drawing using box method*

### Checkpoint 7.6

**Make an oblique drawing of the following shapes using box method.**




## *Centerline Layout Methods*

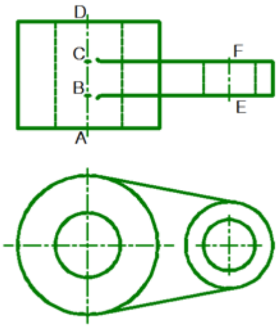
This method is used for objects mainly composed of cylindrical parts. The application of this method is shown in Fig.7.31. The steps are as follow:

**Step I.** Layout the centerlines for all circles at their proper positions.

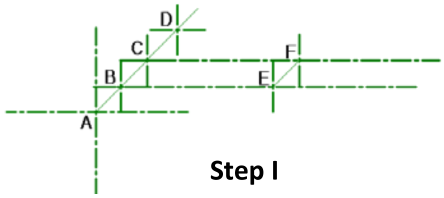
**Step II.** Construct the circles and arcs with light construction lines.

**Step II.** Draw all required tangent lines using tangent line construction method discussed at unit 5 of this text to complete the shape of the object.

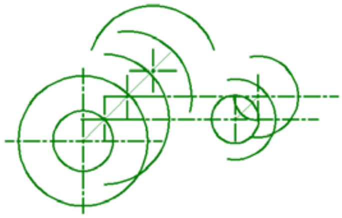
**Step IV:** Darker all the necessary out lines of the final oblique drawing.



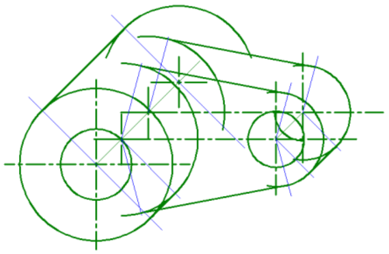

Given views



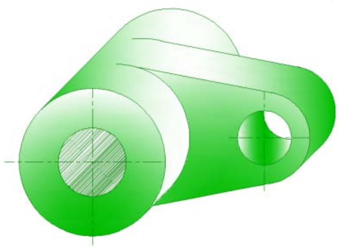

Step I



Step II



Step III



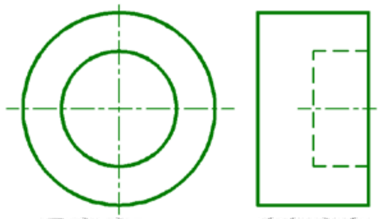
Step IV

*Fig. 7.31 Construction of an oblique drawing using centerline layout method*

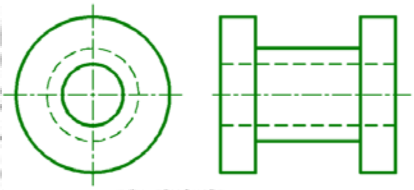
**Checkpoint 7.7**

**Draw oblique drawing of both objects using centerline layout method.**

**a)**



**b)**



## 7.3.4 Circles in Oblique Drawing

### *A. Circles and arcs on any face parallel to the picture plane*

When making oblique drawings, circles on any face of the object parallel to the picture plane are drawn easily as true circles with a compass as shown in Fig.7.32.

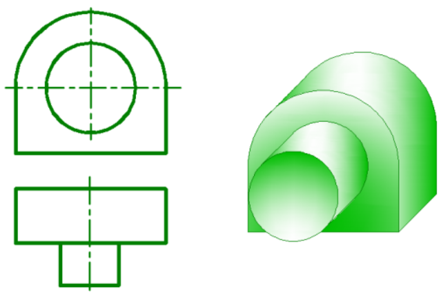
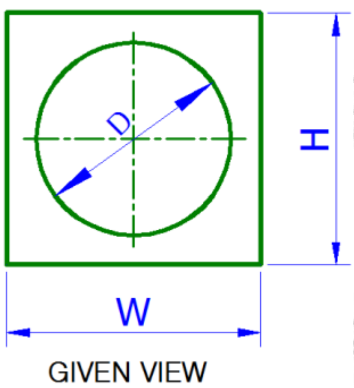
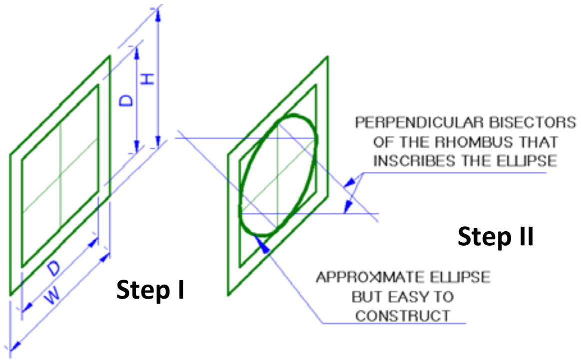


*Fig. 7.32 Circles in oblique drawing*

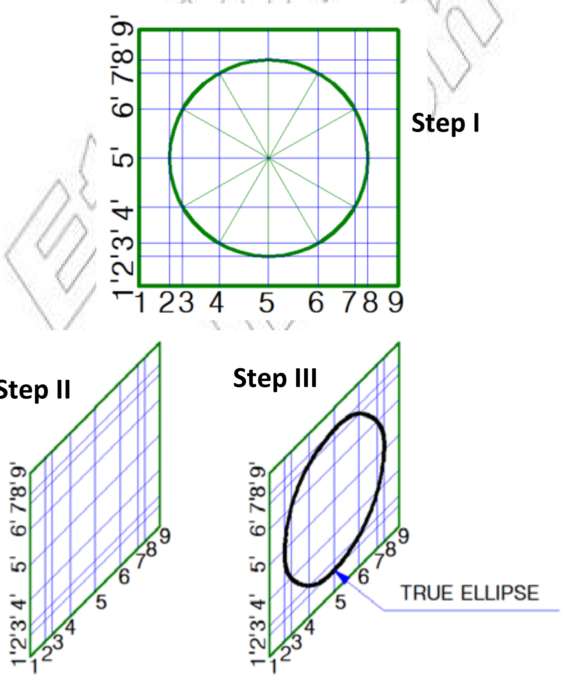
### B. Circles and arcs in the side or top faces of the object.

Circles and arcs that do not face the frontal picture plane will appear as ellipse. For a cavalier oblique drawing approximate four-centre method, and for cabinet and general oblique drawings offset measurement method are used. If the receding axis angle of a cavalier oblique drawing is $30^0$, the ellipse construction method and even the ellipse will be similar to that discussed on isometric drawing. But if the receding axis angle is different from $30^0$ like $45^0$, the ellipse will be constructed using the four-centers established by the intersection of the perpendicular bisectors of the sides of the enclosing rhombus as shown in fig 7.33. If the angles of the receding axis is less than $30^0$ the perpendicular bisectors will intersect inside the rhombus or else the intersection points lie outside of the rhombus.




a) Four centered method




b) Grid construction method

*Fig. 7.33 Four-center and grid construction method on oblique drawing*

### Steps to draw ellipse on receding faces of cavalier oblique drawing: (Fig 7.33 (a))

**Step I.** Draw the rhombus that encloses the ellipse on the receding top or side face using side lengths equal to the diameter of the circle given on the orthographic view .

**Step II.** Draw perpendicular bisectors to all the sides of the rhombus so as to get their intersection points which represent the four centers to complete the ellipse.

**Step III.** Draw arcs tangent to the sides of the rhombus from mid point of one side to the mid point of adjacent side using the four centers established as center, and distance from these centre to the mid point of the sides along the bisectors as a radius.

### *Steps to draw ellipse on the side receding faces of cabinet oblique drawing (Fig.7.33 (b))*

**i.** Draw a square with construction line that encloses the circle given on the orthographic view.

**ii.** Plot points on the given circle either by dividing it into say 12 equal parts or by dividing the horizontal diameter of the circle into some defined number of parts and draw vertical construction lines through these points to get coordinate points on the circle.

**iii.** Draw horizontal and vertical lines through these points plotted on the circle parallel to and touching the sides of the square and label them.

**iv.** Draw the rhombus on the receding face of the oblique box by reducing the side length along the receding line by half scale of its true length.

**v.** Draw the horizontal lines parallel to the receding axis each at interval equal to that shown on the view and the vertical lines parallel to the vertical axis at an interval reduced by half of their true length shown on the view.

**vi.** Properly identify and mark the intersection of the horizontal and vertical lines drawn at step v for the corresponding labeling (numbers or letters).

**vii.** Draw smooth curve through the intersection points or coordinate points obtained at step VI to complete the ellipse.

***Note:* *Ellipse on a general oblique drawing will be constructed in a similar fashion as that of cabinet oblique drawing except the difference of a reducing scale used along the receding axis.***

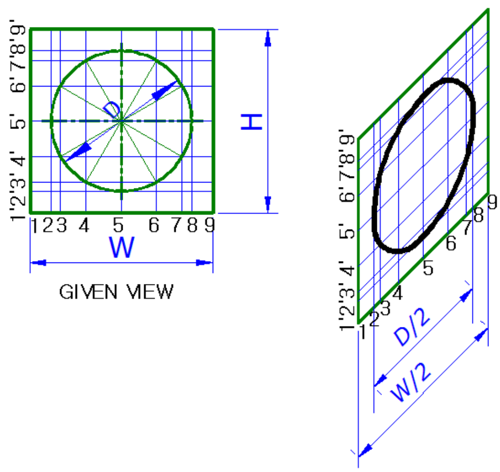



*Fig. 7.34 Offset measurement method for ellipse construction in cabinet and general oblique drawing*

### 7.3.5 Advantages of Oblique Drawing

From the foregoing discussions, it is clear that oblique drawings have the following advantages over isometric drawings:

a. Circles on faces parallel to the picture plane can be easily drawn using a compass.
b. Distortion may be improved by using a reduced scale on the receding axis.
c. Greater range of choice of positions of the axes is available in oblique drawing.

## 7.4 Perspective Projection

1. **Have you seen a picture of a road with the street lamps? Did you observe that the height of the lamps vanishes or gets small as it goes far?**
2. **Bring as many examples as you can from a camera picture which has a vanishing effect.**

Perspective projection also called *central projection* is another method of graphic representation of an object pictorially as it actually appears to the eye of an observer located at a particular finite distance from the object. It more closely approximates the view obtained by the human eye. Geometrically an ordinary photograph is perspective drawing. The principle of perspective is size dimensioning with distance for e.g. when you view a building the parts farthest from your eye appear smaller than the closer parts. If the horizontal edges of the building could be extended, they would appear to meet on the horizon.

A drawing that is made according to the principle of perspective projection is called perspective drawing. Perspective drawings are more realistic than axonometric or oblique drawing because the object is shown as the eye would see it. Since their construction is far more difficult than the other types of pictorial drawings their use in drafting is limited mainly to presentation illustration of a large object such as interior and exterior features of buildings and the preparation of advertising drawings.

*Perspective involves the following four main elements (Fig.7.35)*

***Observer eye:*** the position of the observer eye is called station plane

***Object being viewed:*** an element whose perspective drawing is made on a picture plane.

***Plane of projection:*** the plane on which the perspective view is projected and it is called picture plane

***Projector:*** line from the observer's eye to all point on the object. It is sometimes called visually ray or line of sight.

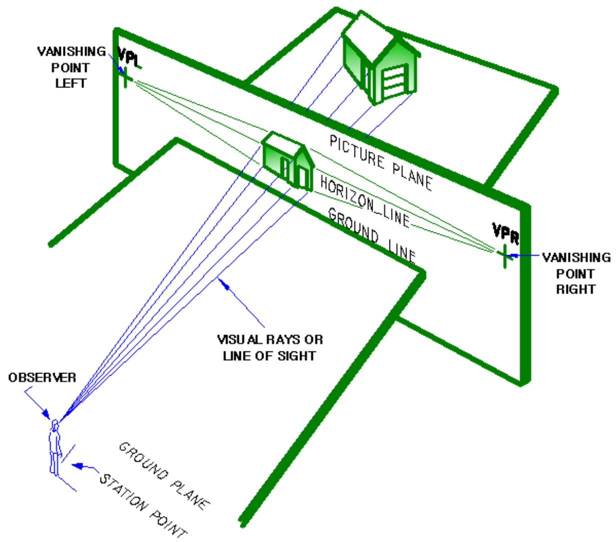



*Fig. 7.35 Perspective projection of a building*

## 7.4.1 Definition of Basic Terms

The definition of some of the basic terms that are commonly used in the discussion of perspective drawings are given below (Refer to Fig.7.35 and 7.36).

***Picture Plane (PP):*** is a vertical transparent plane on which the perspective representation of an object is being projected. It is designated as pp on drawing.

***Station Point (SP):*** is a point where the eye of the observer is located for the resulting perspective projection of an object on pp. It is assumed to be situated at a definite potion relative to the object. It is also known as point of sight.

***Visual Rays:*** are straight lines that are drawn from the station point to the visible corners of the object and pierces the picture plane located commonly between station point and object to establish the perspective projection on PP. They are also referred to as the line of sight.

***Ground Plane (GP):*** is a horizontal plane on which the object is assumed to rest.

***Ground Line (GL):*** is the line of intersection of ground plane with the picture plane.

***Horizon Plane (HP):*** is imaginary horizontal plane assumed above ground plane perpendicular to the picture plane and located at observer's eye level (SP).

***Horizon Line (HL):*** is the line of intersection of horizon plane with the picture plane along which vanishing points lie.

***Vanishing Points (VP):*** are points that always lie on HL to which all the horizontal (side edges) of an object not parallel to the picture plane would appear to meet. However all the lateral edges of the object, parallel to the PP will remains vertical except for three point perspective drawing. We could have one, two or three VPs depending on the type of perspective drawing made.

***Center of Vision (CV):*** is a point that lies on both the HL and PP at central location in front of the observer eye. It also lies along a line from the SP perpendicular to the PP.

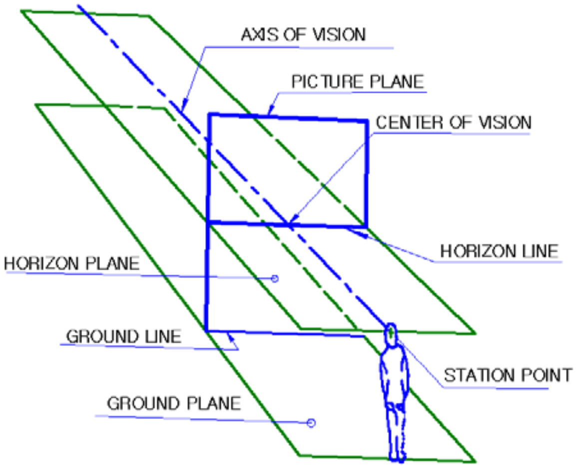



*Fig. 7.36 Perspective nomenclature*

## 7.4.2. Location of Picture Plane and Station Point

### *Location of Picture Plane*

For a given position of the station point and the object, the picture plane may have several positions relative to them as shown in Fig.7.37.

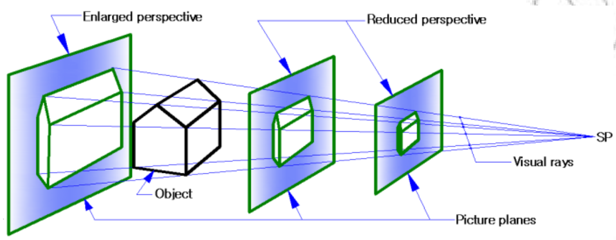



*Fig. 7.37 Relations of object, picture plane and station point*

If the picture plane is placed between the object and the station point, the perspective drawing on the picture plane will be smaller in size than the object. This arrangement is commonly used.

The closer the plane is to the station point, the smaller the perspective drawing becomes as shown in Fig.7.37. If the object is placed between the picture plane and station points, an enlarged perspective drawing will be produced. But this arrangement is very rarely used. The usual practice to prepare the perspective drawing of an object is to place the object in contact with the picture plane. The perspective drawing shown on the entire picture plane will differ in size but not in proportion.

### *Location of station point*

For the assumed picture plane and object position, the effect of perspective drawing of an object will be greatly affected by a change in the position of the station point. The selection of the location of station point depends on the faces of the object required to come into view undistorted and have an attractive appearance.

### *Distance between the station point and the object*

From experience, it is known that the eye is able to see clearly all the picture contained with in a right circular cone of vision having its apex at the eye with an interior angle of approximately $30^0$. This condition is satisfied when the station point is located at a distance from the object at least twice the longest dimension of the object (i.e. x) from the picture plane, as shown in Fig.7.38.

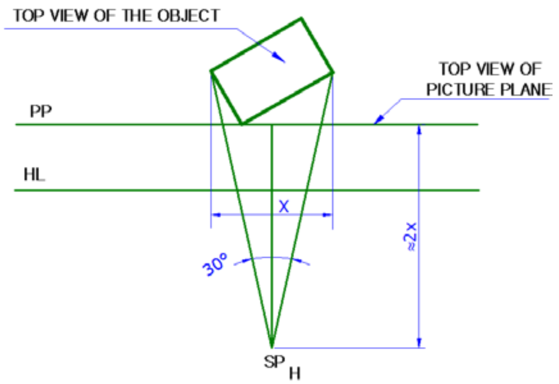



*Fig. 7.38 Location of station point*

For a pleasant perspective drawing the cone of vision should be located near the center of the picture.

If the lateral and elevation angle of visions are greater than 30$^0$, it will result in unpleasant perspective.

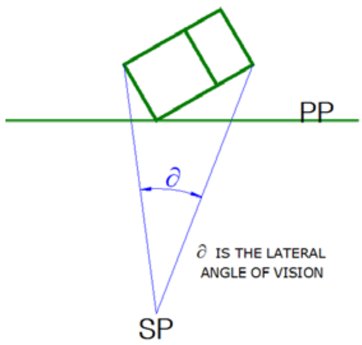
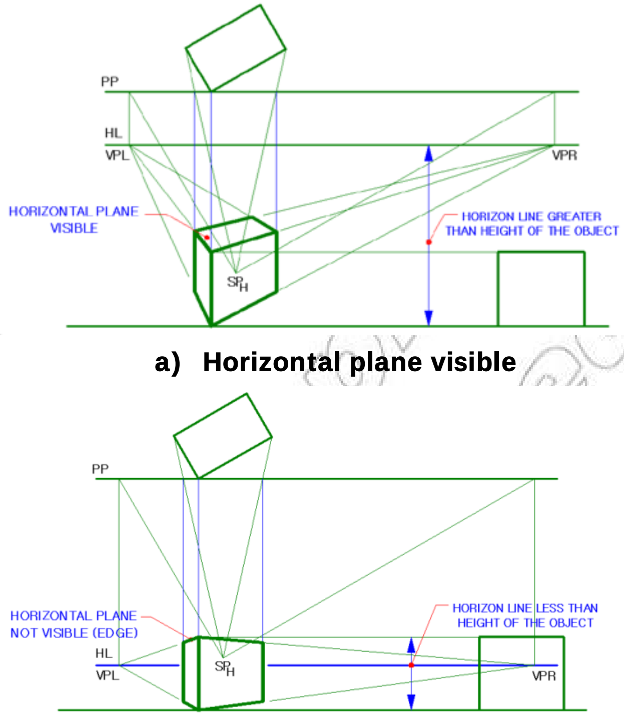



*Fig. 7.39 Lateral angle of vision*

### Elevation of the Station Point

When the top face of the object is more important, the station point and the horizon line should be located above the object. But if the bottom part of the object is to be shown, the station point should be located below the object as shown in Fig.7.39 for angular perspective.




**a) Horizontal plane visible**

**b) Horizontal plane seen as an edge**

*Fig. 7.40 Elevation of the Station Point*

## 7.4.3. Types of Perspective Drawing

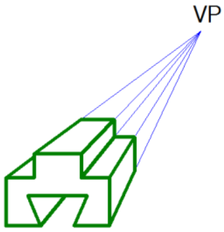
Depending on the position of the object relative to the picture plane & the number of vanishing points required, perspective drawings are classified as:

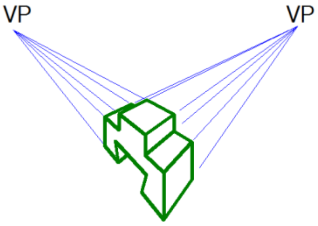
a) Parallel (One-point) perspective,

b) Angular (Two-point) perspective, and

c) Oblique (Three-point) perspective.

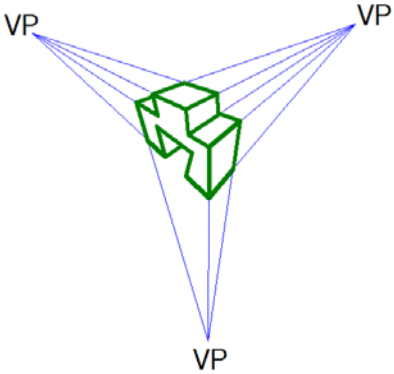
In this text, the oblique perspective drawing is not dealt in detail because of its rare application.




a) Parallel
One vanishing point

b) Angular
Two vanishing points




c) Oblique Three vanishing points

*Fig. 7.41 Types of perspective drawings*

**A) *Parallel (one-point) perspective:*** is a type of perspective drawing obtained by placing an object such that one of its principal faces is made to be parallel to the picture plane so that it will be drawn as true size and shape. Here two principal axes are parallel with the picture plane where as the third axis perpendicular to the plane. All parallel edges of the object that are perpendicular to the picture plane will converge (meet) at one point on horizon line called vanishing point. It is similar to oblique drawing except that all the receding edges (lines) will converge to the varnishing point on horizon line. This perspective is commonly used for representing the interior view of a building and machine parts. There is one vanishing point.

**B) *Angular (two-point) perspective:*** is a type of perspective drawing obtained by placing an object such that two principal faces along the width and depth dimension are inclined at an angle with picture plane and recede to the two vanishing points on horizon line. All the vertical edges of the object along the height dimension are arranged parallel to the picture plane. It is similar to axonometric drawing except that the receding edges are converged to the two vanishing points on the horizon line. It is commonly used for representing exterior view of an object e.g. building. By changing the relationship between the horizon line and ground line, we can get the following types of angular perspective: (Fig.7.42)

1. ***Area view (Bird's eye view):*** is a perspective view obtained by placing horizon line above ground line at any convenient distance. It is used to show top, front and side faces of the object.

2. ***General view (Human's eye view):*** is a perspective view obtained by placing horizon line above ground line at an average adult human's height, of course passing through the object e.g. it is used mostly for perspective view of a building.

Here only two faces (front and side) will appear on the perspective drawing.

3. ***Ground view:*** is a perspective view obtained by placing horizon line and ground line at the same level (coinciding them). It is like a view obtained by an observer laying on the ground and it is commonly used for a perspective view of a building. Like general view, only two faces i.e. (front and side) will come into the perspective view.

4. ***Worm's eye view:*** is a perspective view obtained by placing horizon line below ground line. It is rarely used. It is used to show three faces (front, side and bottom). Commonly used for smaller objects or machine parts.

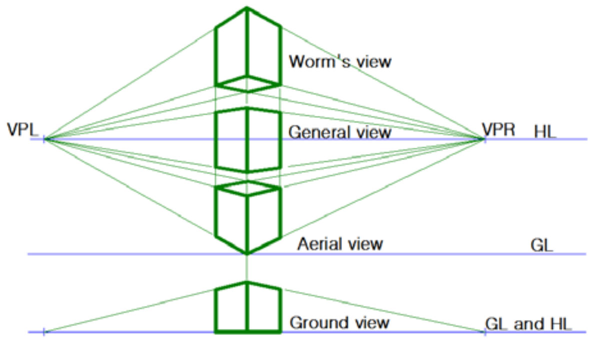



*Fig. 7.42 Objects above, through, and below the horizon*

**C) *Oblique (three-point) perspective:*** is a type of perspective drawing obtained by placing an object such that all the three principal faces are at an angle with the picture plane. All the receding parallel edges of the object along the width and depth dimension will converge to two vanishing points on horizon line and the vertical edges along the height of the object will converge to the third vanishing point not lying on horizon line. Therefore, three varnishing points are used.

## 7.4.4. Construction of Perspective Drawing

### *i. Parallel (One-point) perspective*

As discussed earlier, this type of perspective requires one face to be positioned parallel to the picture plane and the other perpendicular to it. Station point is located so as to enable see the right or left side face of the object. If the right face is required to be shown, the station point should be located to the right of the object and vice versa.

***Steps to prepare parallel perspective drawing of an object (Fig.7.43):***

1. Begin the drawing by establishing the three edge view lines. i.e. PP, HL and GL at any convenient distance depending on the faces of the object required to be shown on the perspective drawing.
2. Draw the top view with its front face in contact with the picture plane (as a usual practice) or at some distance apart from it.
3. If sufficient space is available and required, draw the front or side view on one extreme end of ground line to a convenient left or right direction.
4. Complete the front face of the perspective drawing on ground line, showing its true shape and size by drawing projectors from top and side (front) view corners to get the various width and height informa-

tion of the object respectively. If no side (front) view is shown on GL take the height information of various features from the orthographic side or front view of the object.

5. Establish the station point at a distance greater than or equal to twice the overall width of the object from picture plane to the left or right direction of front face as required. So that the cone of vision becomes less than $30^0$ for a pleasant appearance of the perspective drawing.
6. Locate the vanishing point on horizon line by drawing a projector from station point perpendicular to horizon line.
7. Draw visual rays from the station point to all rear or back corners, if the top view is in contact with PP or to front and rear corners, if the top view doesn't have any contact with PP. These visual rays will intersect pp at various points to establish "piercing points" representing the back edges of the object in the perspective drawing.
8. Draw projectors from all front corners to the vanishing point located on HL.
9. Draw projectors from all piercing points of PP obtained at step 7 vertically down ward to intersect the corresponding receding edges drawn at step 8 and establish all the desired corners of the perspective drawing.
10. Connect the intersection points so obtained at step 9 to complete the perspective drawing.

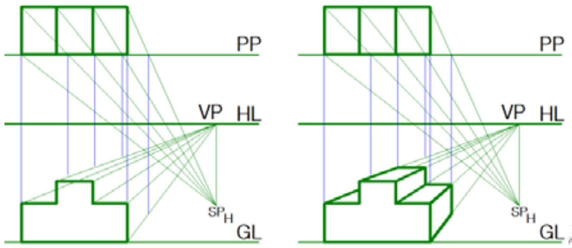



*Fig. 7.43 Steps in parallel perspective drawing*

### ii. Angular (Two-point) perspective

This type of perspective requires two faces of the object to be positioned at an angle with PP.

**Steps to prepare angular perspective drawing of an object are:**

1. Draw the three edge view lines i.e. PP, HL, GL at any convenient distance and arrangements between HL and GL depending on the faces of the object required to be shown on perspective drawing as shown in Fig 7.44.
2. Draw the top view in such a position that, the longer principal receding edge makes an angle of $30^0$ and the shorter edge $60^0$ with the picture plane for a better perspective drawing. Its front vertical corner is in contact with, as a usual practice, or with out any contact to the picture plane as required.
3. Draw the front or side view of the object on one convenient side of ground line from which different feature heights of the object are transferred to the perspective drawing.
4. For a good perspective drawing locate the SP at a distance greater than or equal to twice the diagonal length of top view i.e. parallel to the PP so that the perspective

drawing will be contained in a cone of vision less than $30^0$. It can be located to the left or right direction of the front corners as required but many times in line with the front corner (approximately around the center of the object to reveal both receding faces into perspective view.

5. Locate the two vanishing point left (VPL) and varnishing point right (VPR) on the horizon line by first drawing projectors from the SP parallel to the two receding principal edges of the top view so as to get corresponding intersection points on pp. Drop vertical projectors from these intersection of PP down to the horizon line.
6. Draw vertical projector from the front corner of top view having contact with PP down to GL to establish a line called line of sight or true height line.
7. Draw horizontal projectors from all height corners of front or side view located on GL to the line of sight and then to the two valuation points.
8. Draw visual rays from the SP to all corner of top view. These projectors will intersect the pp at various points to establish piercing points representing the back edges of the object in the perspective drawing.
9. Draw vertical projectors from all these piercing points of PP down to intersect projectors from the line of sight to VPS and determine the width and depth of all desired corners of the perspective drawing.
10. Connect all the required intersection point obtained at step 9 to completed the perspective drawing of the object.

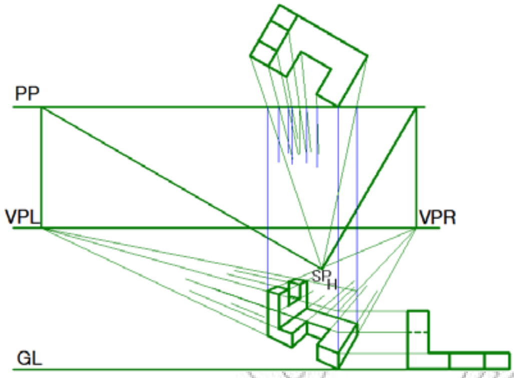
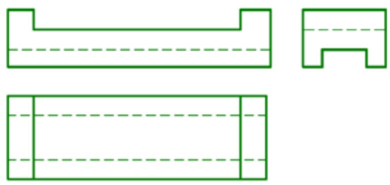
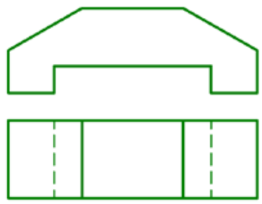



*Fig. 7.44 Two-point or angular perspective drawing of an object*

## Checkpoint 7.8

**Draw one point and two point perspective drawing of the following objects whose views are given in fig below (a) and (b) respectively.**





**b)**

## 7.4.5. Circles and Arcs in Perspective Drawing

Circles and arcs of an object facing the picture plane will be constructed as a true circle using compass in one point perspective and as an ellipse if they are on receding face, and all faces of two point perspective to be constructed by joining points of intersection obtained.

### In parallel (one-point) perspective

Circles or arcs will be constructed as a true circle or arc whose radius varies depending on its closeness to the picture plane. The one closest even in contact with the PP will be draw as true circle or arc, where as the other farthest from the pp will be drawn as a smaller size circle or arc whose radius can be obtained by the usual principle of perspective drawing construction (see Fig. 7.45).

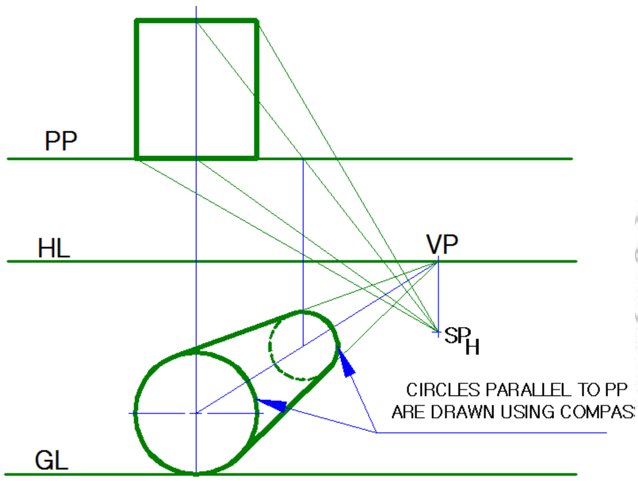



*Fig. 7.45 One-point perspective of a cylinder*

### In angular (tw0-points) perspective

Circles or arc of an object will be constructed as an ellipse whose size and shape varies depending on its angle of inclination with the picture plane.

### Steps to draw a circle in angular (two point perspective: (Fig 7.46)

1. Draw the three edge view lines (i.e. PP, HL, &GL), SP, VP, the top view and front or side view as required based on the usual principle of perspective drawing construction.
2. Enclose the front or side view of the circle given on GL with square and than divide the circle into say 12 equal parts (divisions) and label them.
3. Project each division point of the circle to the top and side edges of the enclosing square and label them accordingly. Show all corresponding labeling on the top view.
4. Draw projector lines from the SP to all labeled division points of top view.
5. Draw vertical projector lines from all piercing point of PP down to perspective drawing.
6. Draw horizontal projector lines from all division points of the front or side view of circle on GL to the line of sight or vertical edge of the perspective square and then to the vanishing point.
7. Connect the points of intersection located by the intersection of vertical projection lines dropped down from all piercing points of PP and the vanishing lines drawn from all points of line of sight to VP using irregular circle.

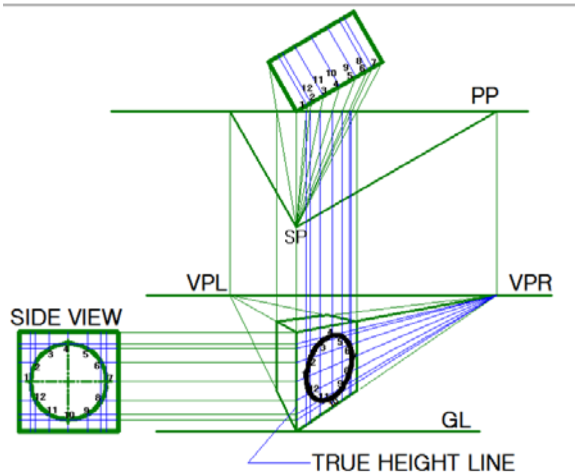



*Fig. 7.46 Construction of circle in two-point perspective*

Other easier method of perspective circle construction lying on horizontal plane is done using the "ground line" method. In this method the GL is temporarily moved from its original position to the height of the circle as shown in Fig 7.47.

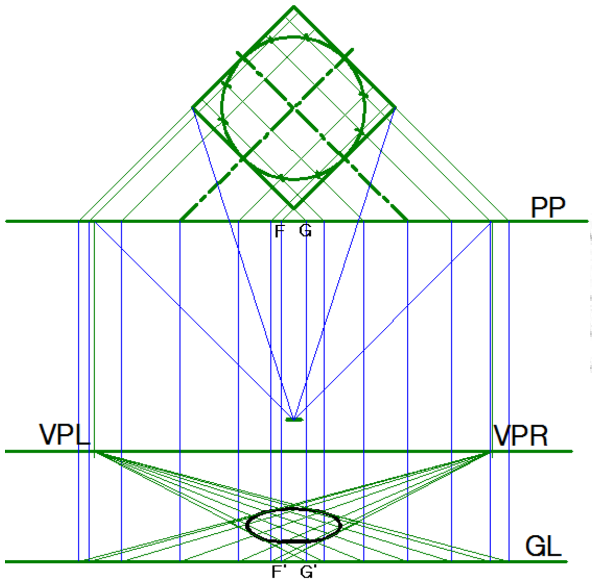



*Fig. 7.47 Construction of circle on horizontal plane*

***Note:** Construction of perspective drawing for other features not discussed in this text book will be covered up at a higher level of study.*

# UNIT SUMMARY

The three classifications of pictorial projections are axonometric, oblique, and perspective. Isometric sketches are the most popular among the various axonometric drawings, because they are the easiest to create. Both axonometric and oblique projections use parallel projection. As the axis angles and view locations are varied, different pictorial views of an object can be produced.

Axonometric projection is a kind of orthographic projection that an object and its Cartesian coordinate system are projected onto a projection plane. Similarly the object is inclined to the observer so that all three dimensions can be seen in one view.

Oblique projection is a form of parallel projection and the angle between projectors and projection plane is not fixed, 30~60 degrees are preferable, because minimum distortions of the object are caused. In oblique projection application rules are: make complex features (such as arcs, circles, irregular surfaces) parallel to the frontal plane; and the longest lines of an object should be parallel to the frontal plane.

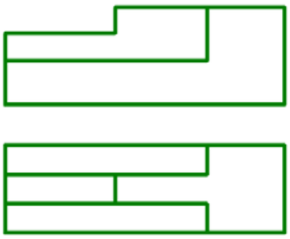
Perspective projection use converging lines to produce a pictorial view. The converging lines recede to vanishing points that produce a realistic looking image. Perspectives are commonly used in architectural work to create realistic scenes of buildings and structures. In this chapter you learned there are three types of perspective projections: one-, two-, and three-point. Each type refers to the number of vanishing points used in the construction of the drawings. Other variables, such as position of the ground line in relation to the horizon line, can be controlled to produce virtually any view of an object.

## Exercise I

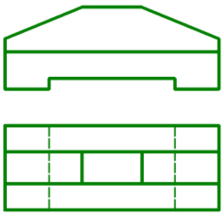
1. Define oblique projection.
2. List and describe the differences between the three different types of oblique drawing.
3. Define axonometric.
4. Define isometric, diametric, and trimetric drawings.
5. Sketch the axes used for an isometric drawing.
6. What is the general rule used for hidden lines in isometric drawings?
7. Give examples of pictorial drawings which are used in industry.
8. Sketch an isometric cube then show how isometric ellipses would be drawn on each face of the cube. Add center lines to the ellipses.
9. What are the three angular measurements of isometric drawing axes?
10. Describe perspective projection theory. Use sketches if necessary.

## Exercise II

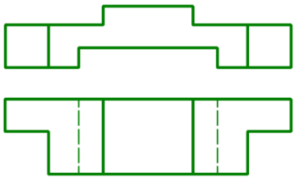
***Make the isometric drawing of the following objects by taking direct measurements from the given views.***



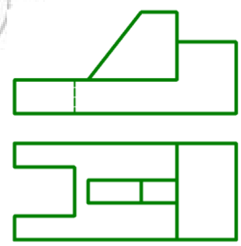
a)



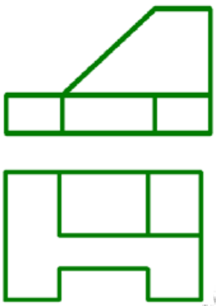
b)



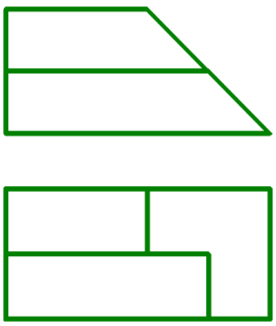
c)



d)



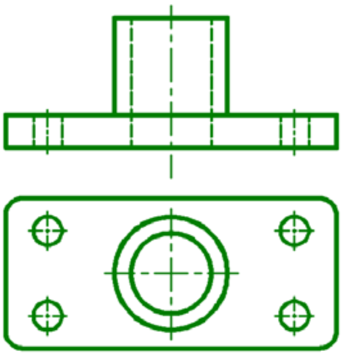
e)



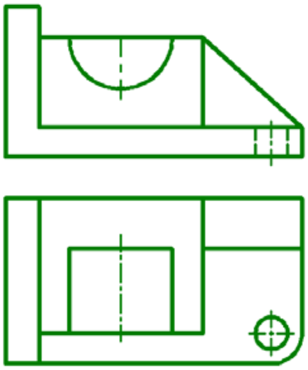
f)

## Exercise III

**Make the isometric drawings by taking direct measurements.**



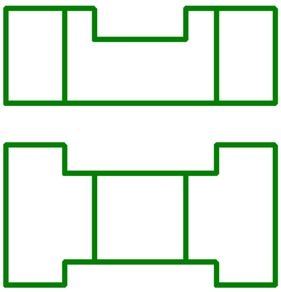
a)



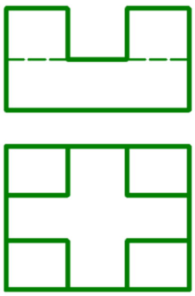
b)

## Exercise IV

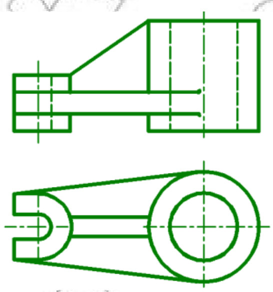
**Draw an oblique drawing of the objects whose views are given below use appropriate scale.**



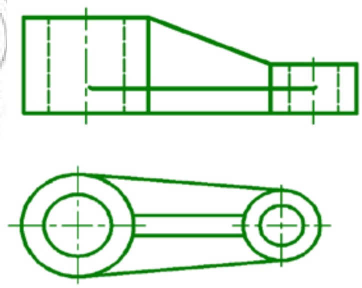
a)



b)



c)

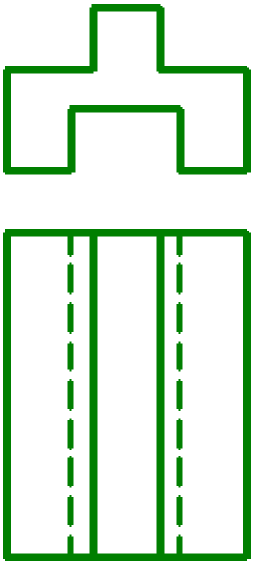


d)

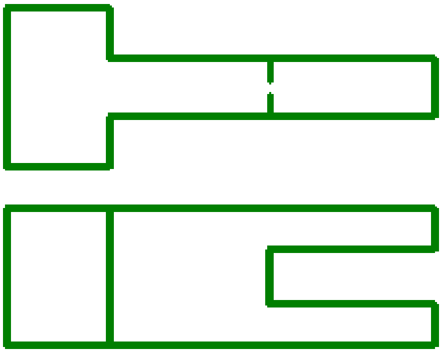
## Exercise V

***Draw the one point and two point perspective drawing of the following shape***

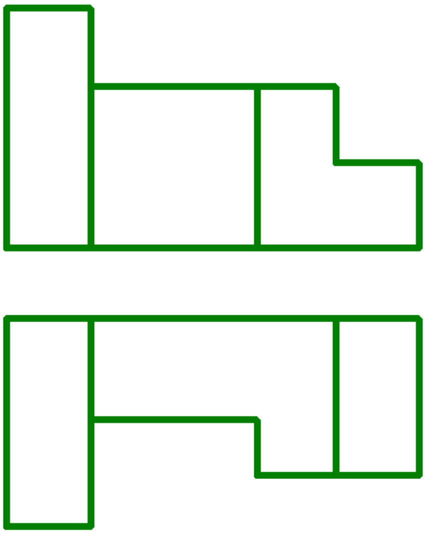
**1.**



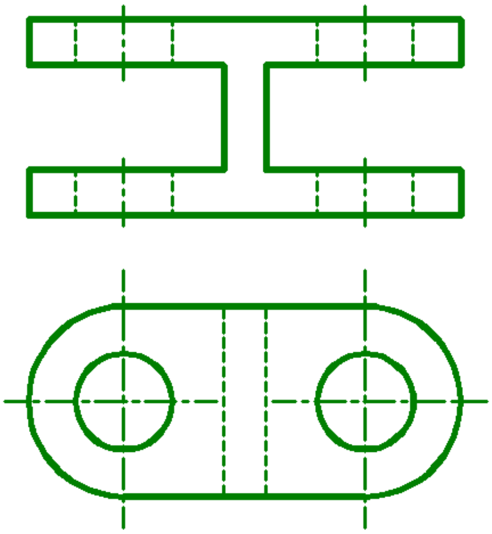
**2.**



**3.**

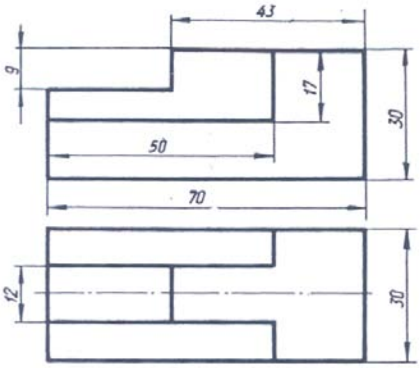


**4.**

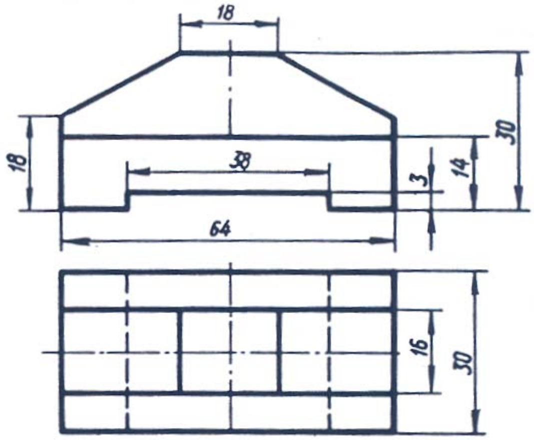


## Project

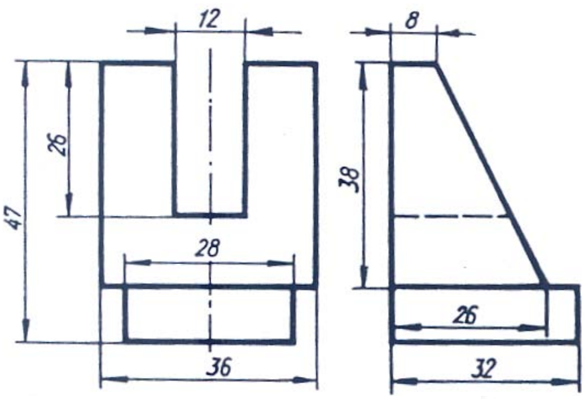
Given two projection of a model, construct a third one (if necessary) and a pictorial drawing of the model.



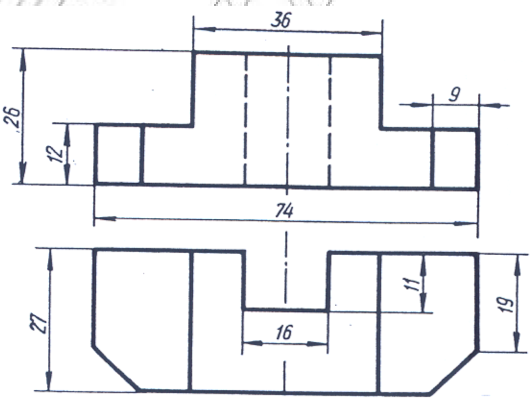

1.




2.




3.




4.