ENGINEERING DRAWING

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Engineering drawing:

An engineering drawing, a type of technical drawing, is created within the technical drawing discipline, and used to fully and clearly define requirements for engineering items.

Common features of engineering drawings:

Drawings convey the following critical information:

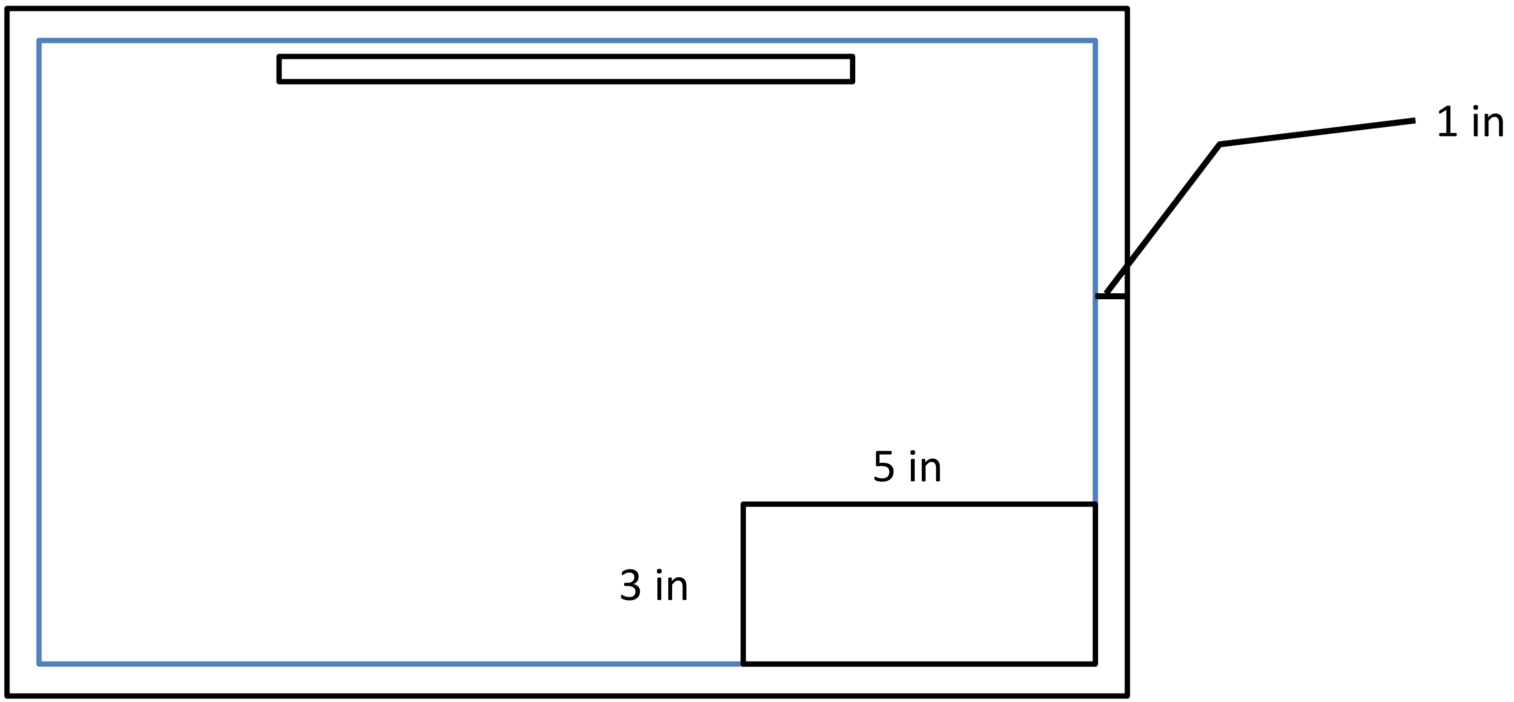
- *Geometry* – the shape of the object; represented as views; how the object will look when it is viewed from various angles, such as front, top, side, etc.
- *Dimensions* – the size of the object is captured in accepted units.
- *Tolerances* – the allowable variations for each dimension.
- *Material* – represents what the item is made of.
- *Finish* – specifies the surface quality of the item, functional or cosmetic. For example, a mass-marketed product usually requires a much higher surface quality than, say, a component that goes inside industrial machinery.

List of instruments and materials:

- Drawing board (with clips).
- Drawing Paper.
- T-scale.
- 45° and 30°-60° triangles (Set Square).
- A compass.
- 12-inch scale.
- One 6H and one 3H pencil.
- Pencil eraser and cleaning rubber.
- Piece of soft cloth to keep drawing clean.

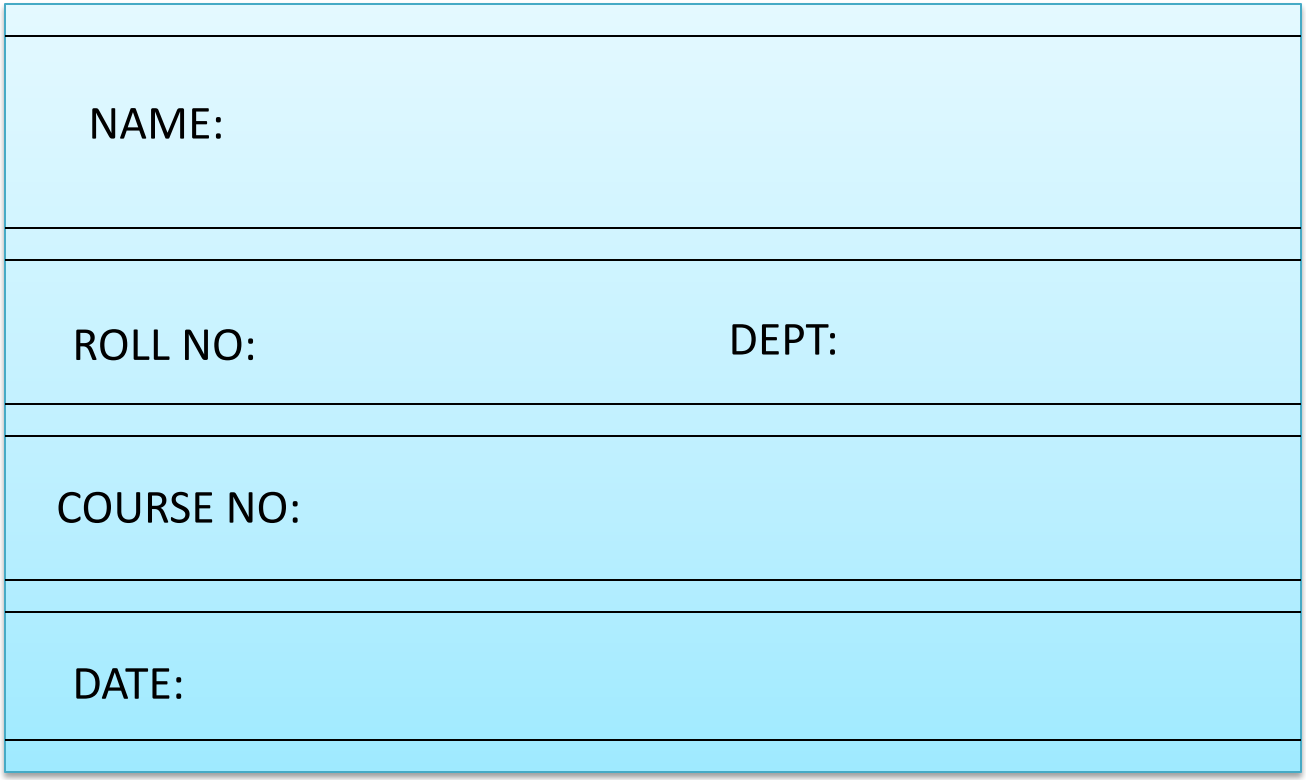
Preparation for Drawing

- Draw a boarder having 1 inch thickness.
- At bottom right corner draw a box having 5 inch width & 3 inch height , known as ‘***Title Box***’ .(The purpose of the box is to write-down your ID)



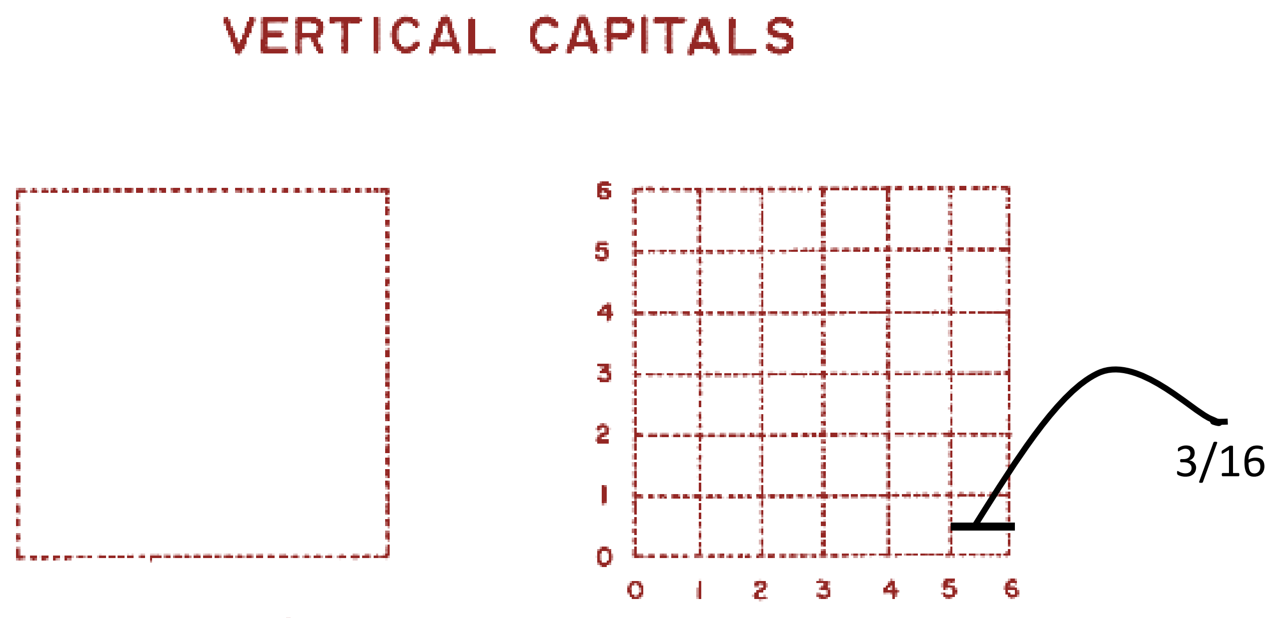
Technique to draw a 'Title Box'

- Little box thickness is 1/16 & Larger box thickness is 8/16. (There are normally 16 lines in 1 inch, according to engineering scale)



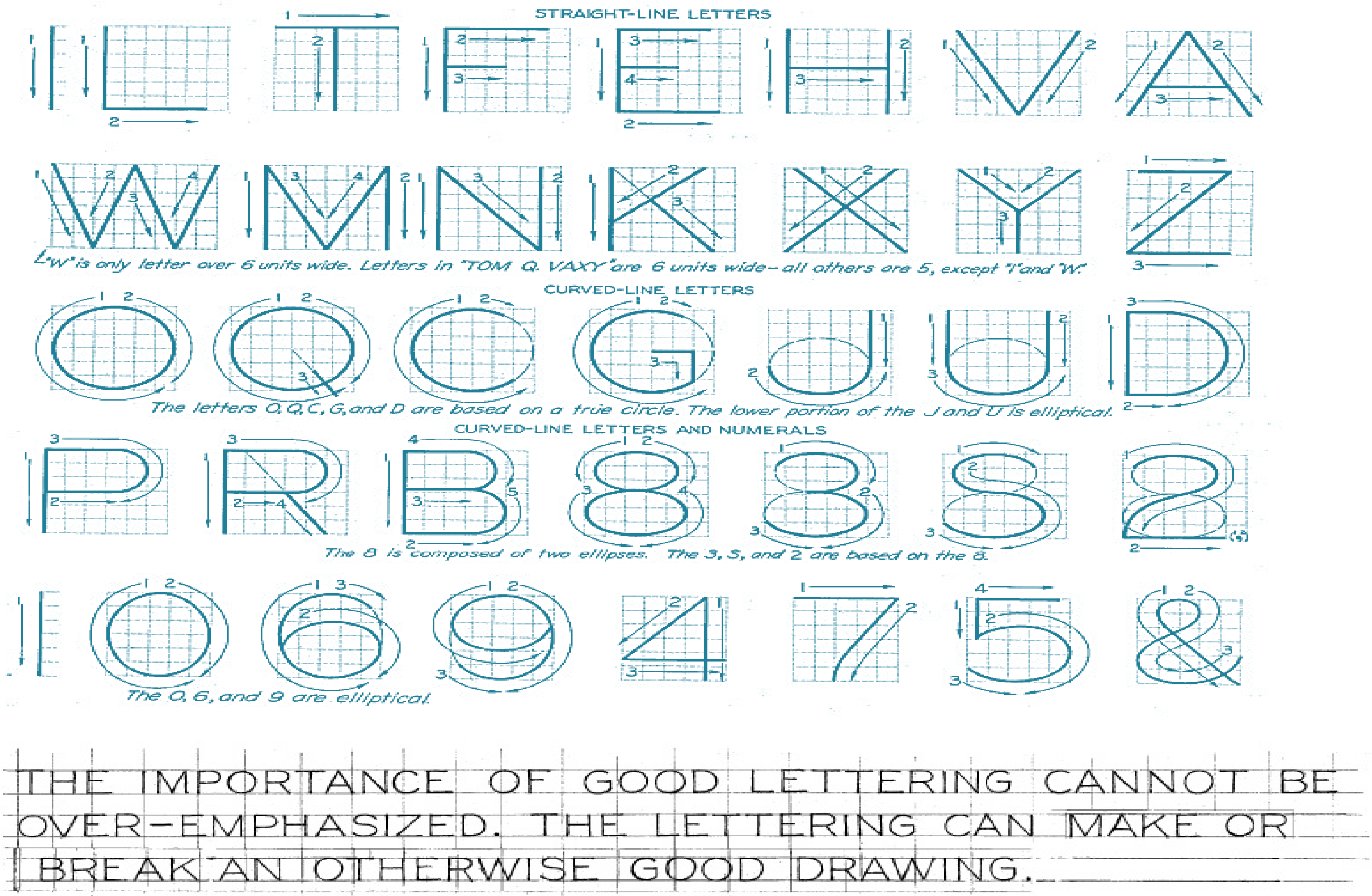
Scale Drawing

Freehand Lettering

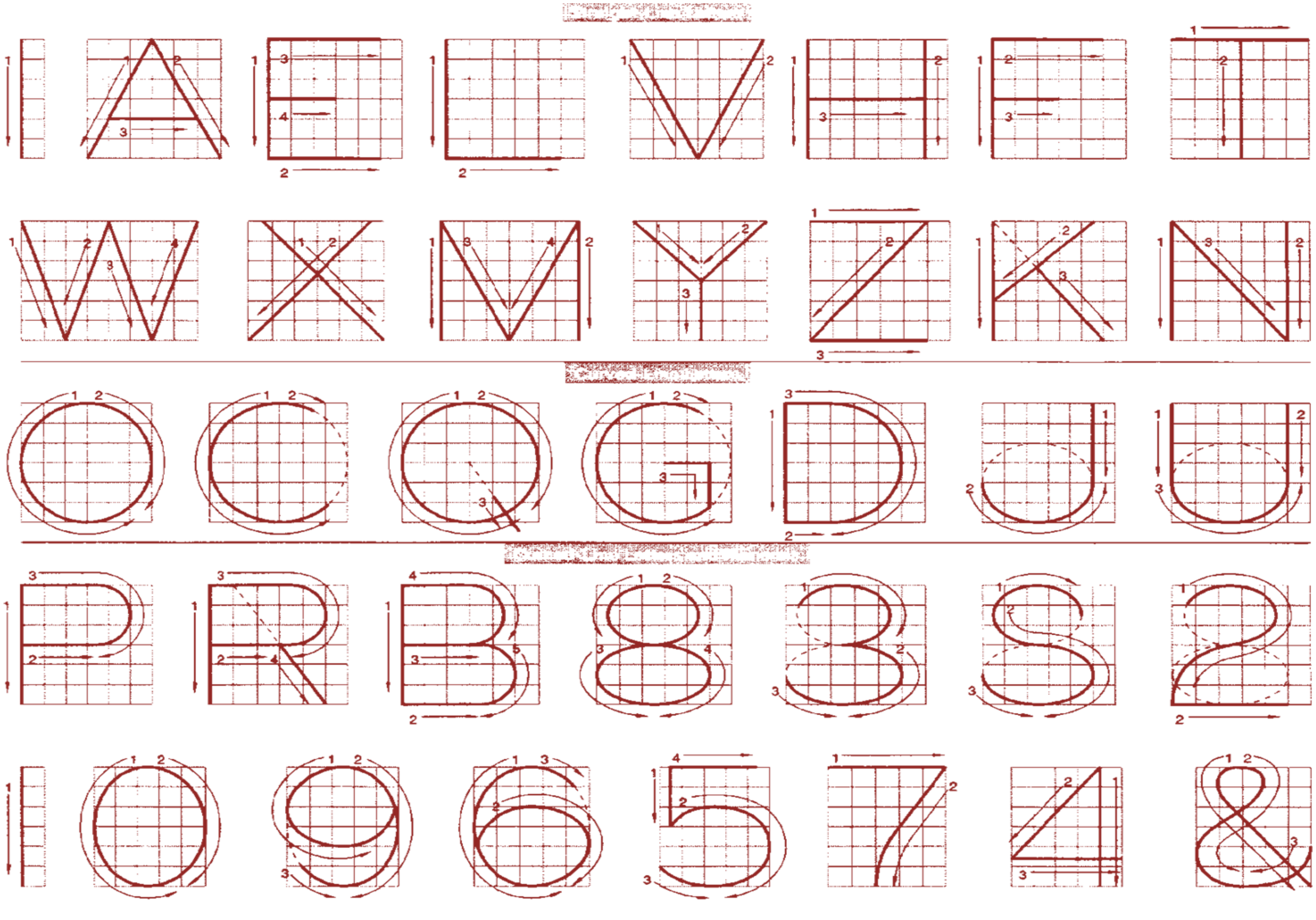


- Vertical capital letters are preferred for most technical work. They are formed within a 6 by 6 grid.
- The distance between the two lines are 3/16.

Lettering Technique



Clear View



Isometric Views

Isometric Projection & Isometric drawing

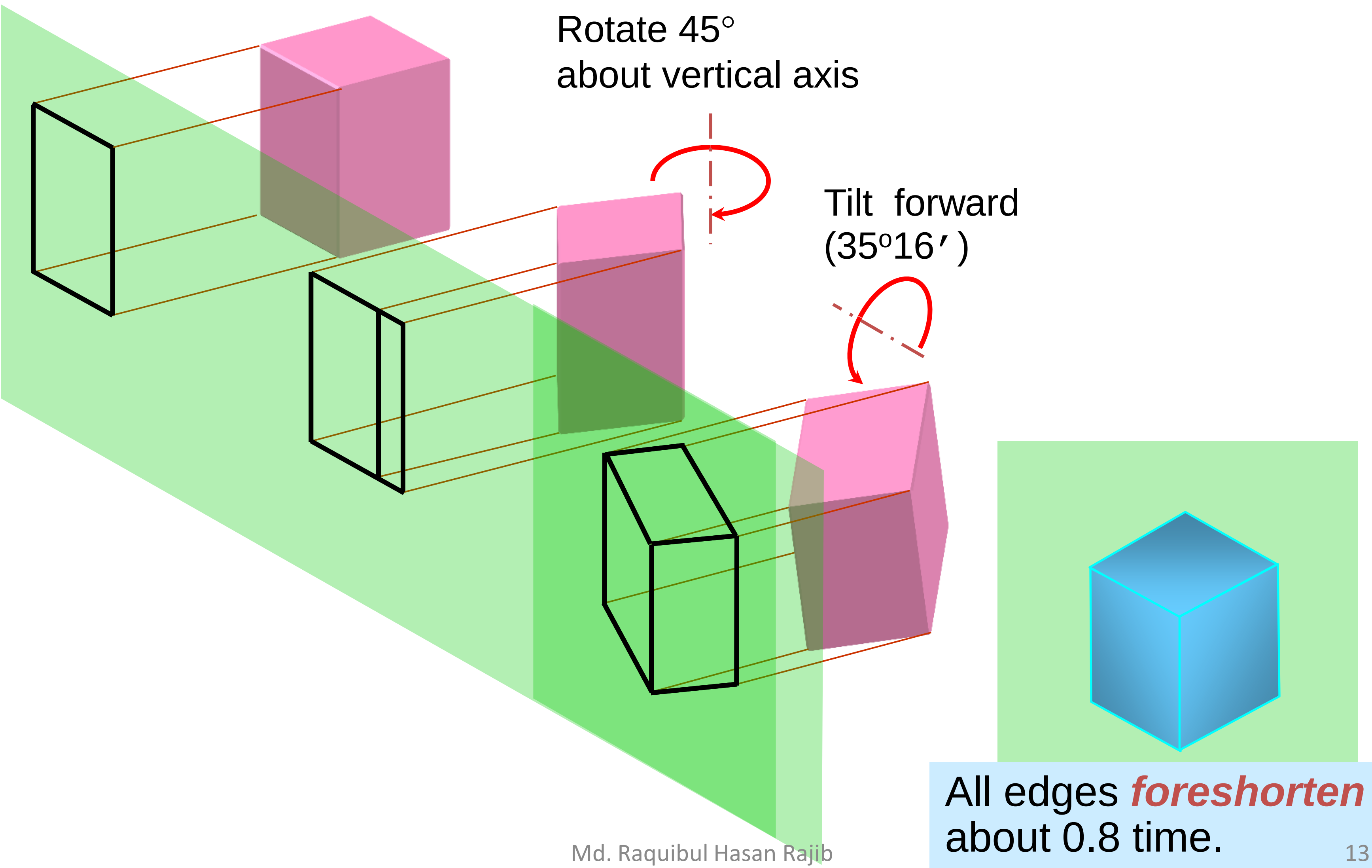
Introduction:

“**Iso**” means „**equal**‟ and “**metric projection**” means ‚**a projection to a reduced measure**‟.

An *isometric projection* is one type of pictorial projection in which the three dimensions of a solid are not only shown in one view, but also their dimension can be scaled from this drawing

Isometric View	Isometric Projection
Drawn to actual scale.	Drawn to isometric scale.
When lines are drawn parallel to isometric axes, the true lengths are laid off.	When lines are drawn parallel to isometric axes, the lengths are foreshortened to 0.81 time the actual lengths.

Isometric Projection

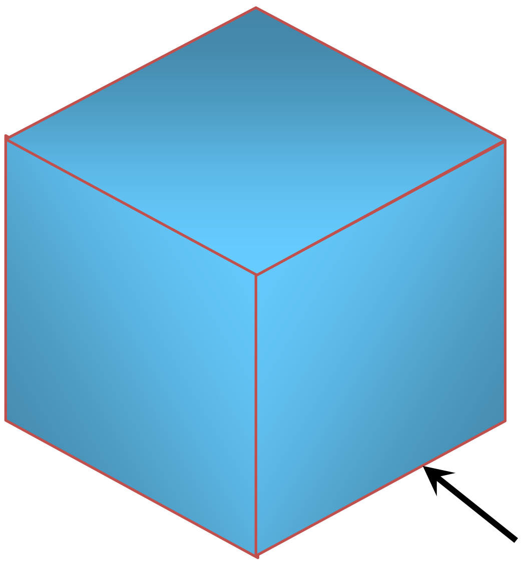


All edges ***foreshorten***
about 0.8 time.

Isometric Drawing

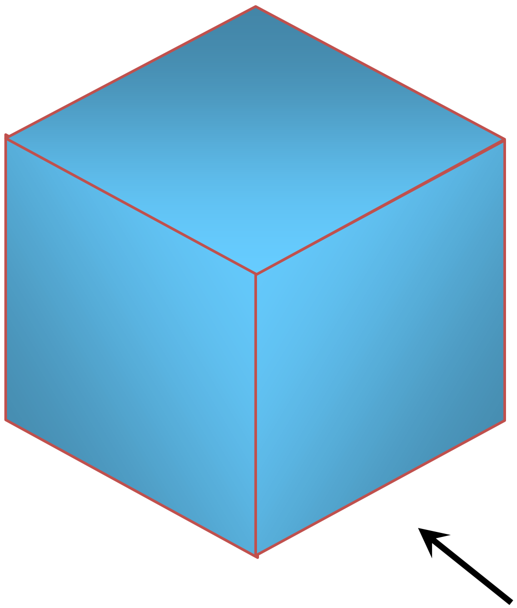
Isometric drawing is a drawing drawn on an isometric axes using ***full scale***.

Isometric projection
(True projection)



Forshorten

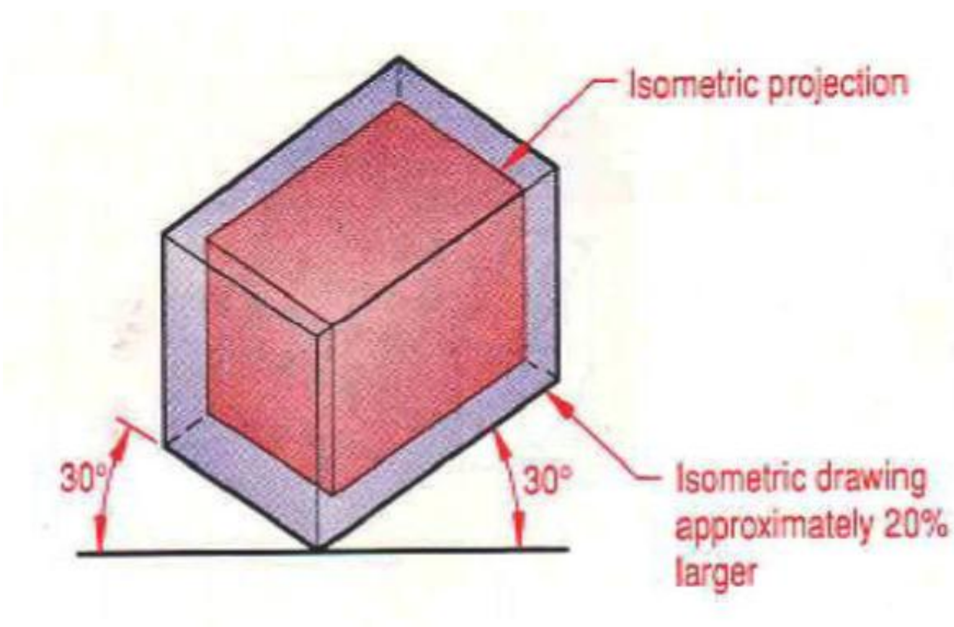
Isometric drawing
(Full scale)

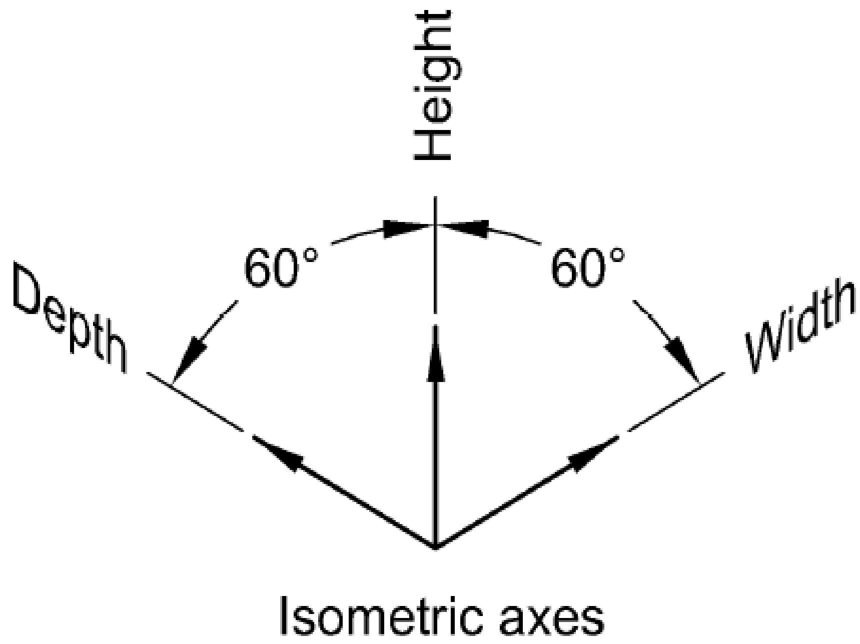


Full scale

Isometric Axes:

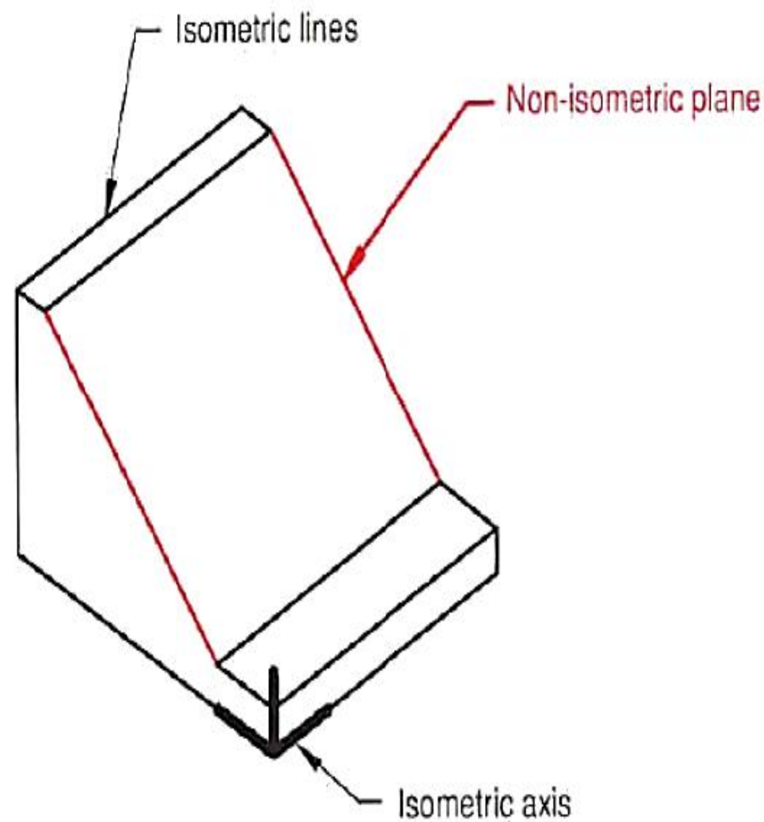
An *isometric drawing is an axonometric pictorial drawing for* which the angle between each axis equals 120 degrees and the scale used is full scale





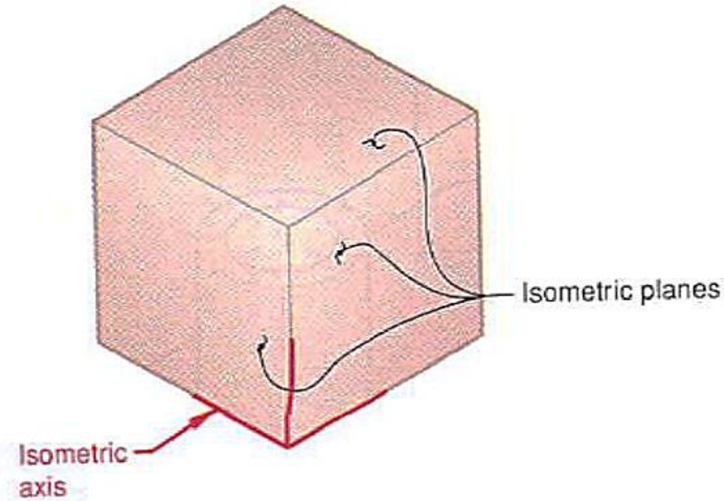
Isometric and Non-isometric lines & planes:

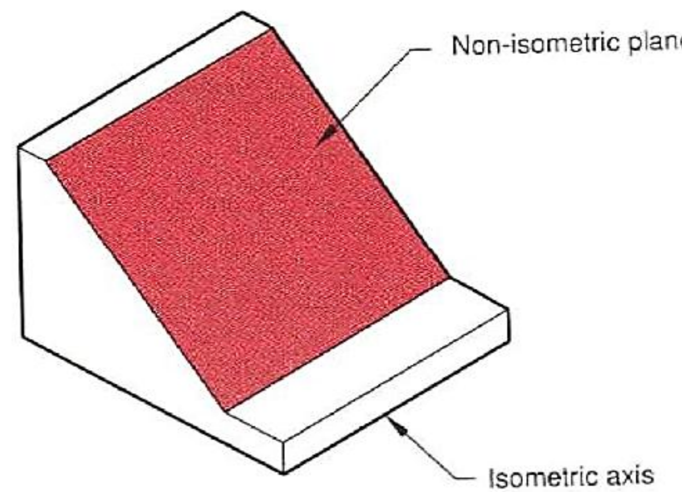
- In an isometric drawing, true length distances can only be measured along **isometric lines**, that is, lines that run parallel to any of the **isometric axis**.
- Any line that does not run parallel to an isometric axis is called a **non-isometric line**
- Non-isometric lines include **inclined** 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.**

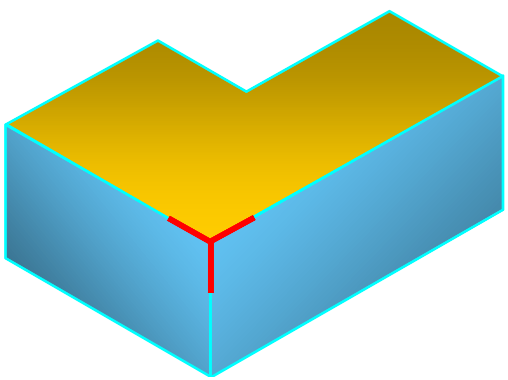




Positions of Isometric Axes

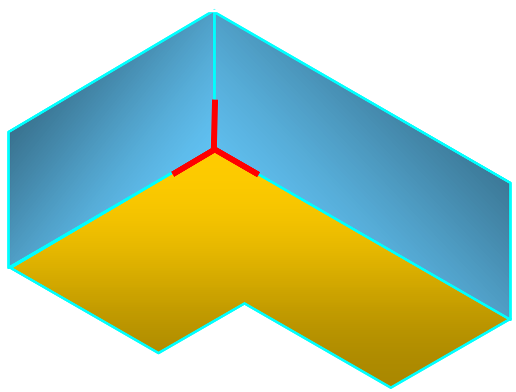
Isometric axes can be arbitrarily positioned to create different views of a single object.

Regular isometric



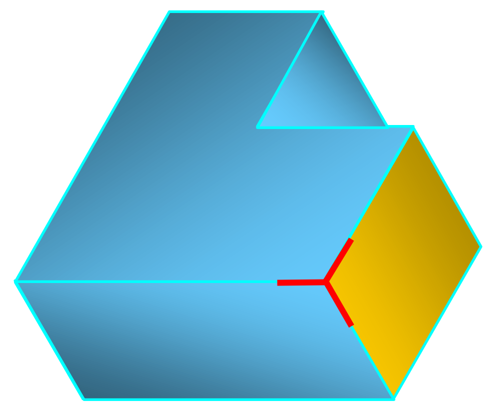
View point is looking down on the top of the object.

Reverse axis isometric



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

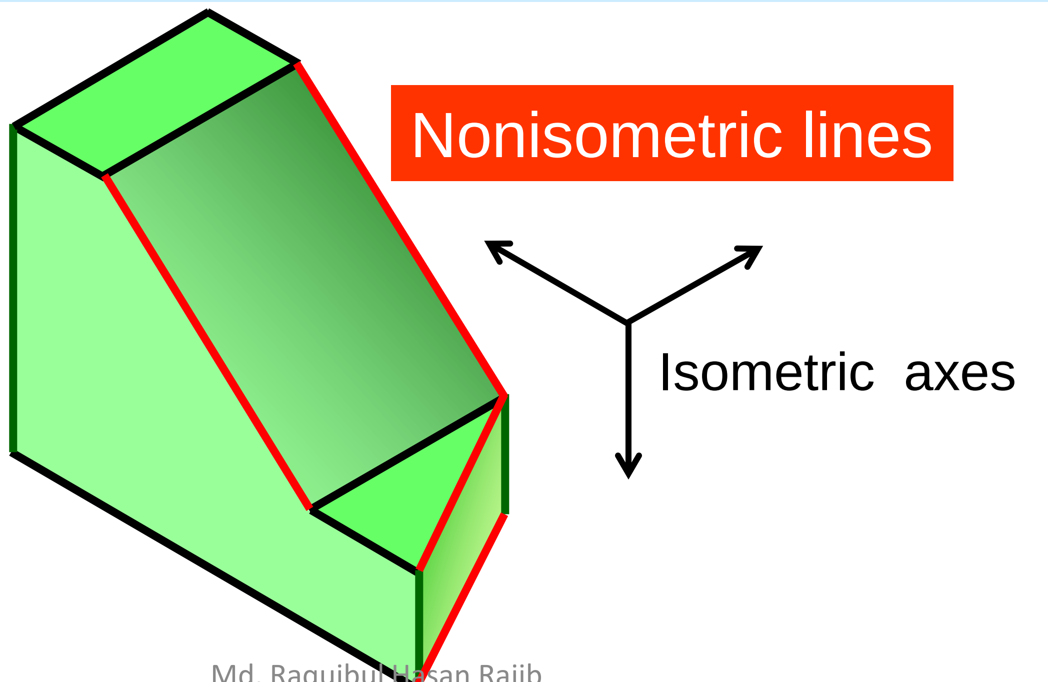
Long axis isometric



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

Distance in Isometric Drawing

- **True-length distances** are shown along isometric lines.
- ***Isometric line*** is the line that run ***parallel*** to any of the isometric axes.



Isometric Sketching

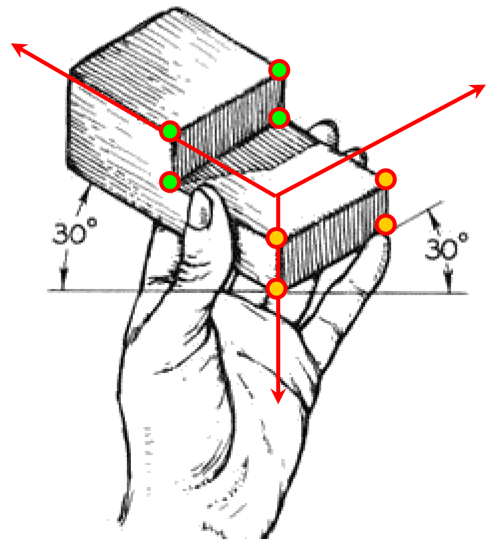
Sketch from an actual object

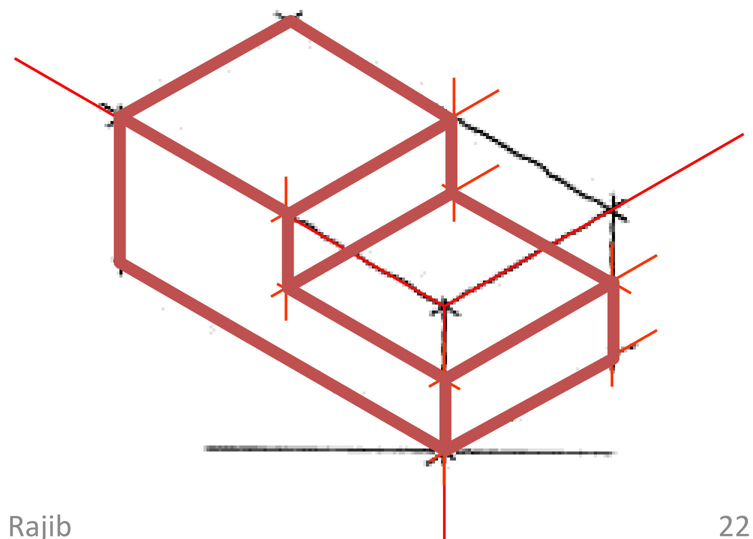
1. Place the object in the position which its shape and features are clearly seen.
2. Define an isometric axis.
3. Sketching the enclosing box.
4. Estimate the size an and relationship of each details.
5. Darken all visible lines.

Sketch from an actual object

STEPS

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

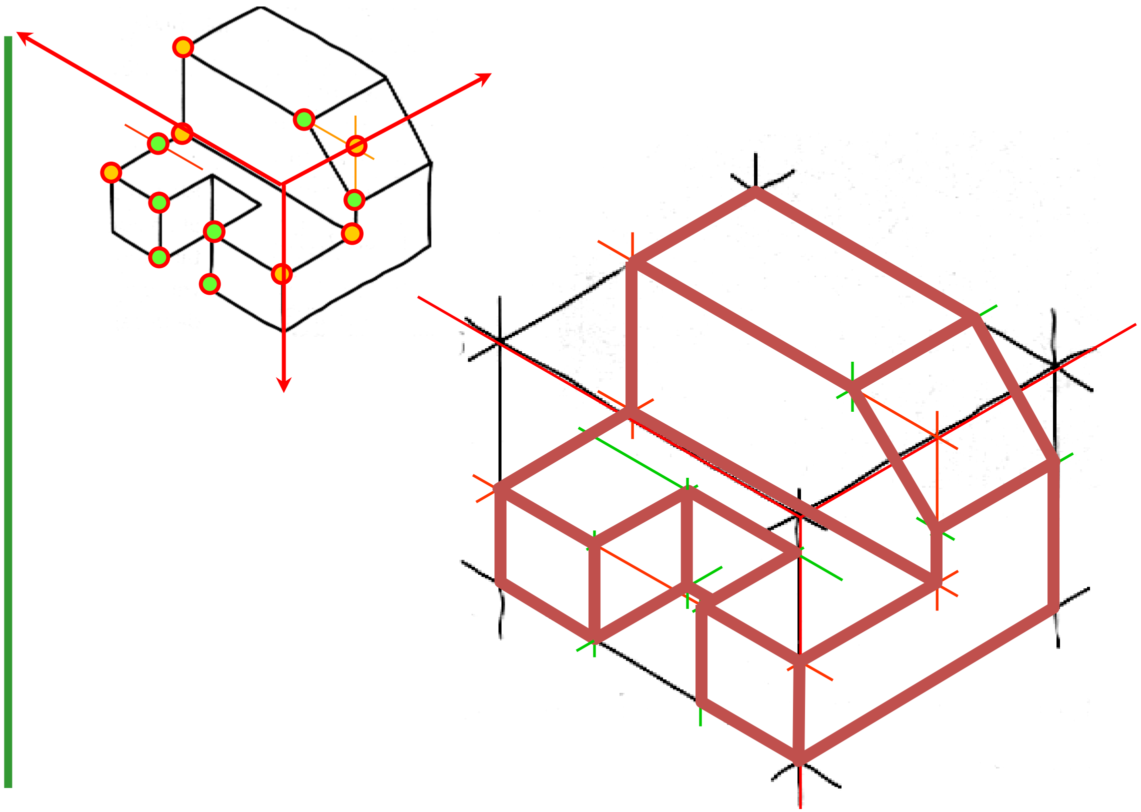




Sketch from an actual object

STEPS

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

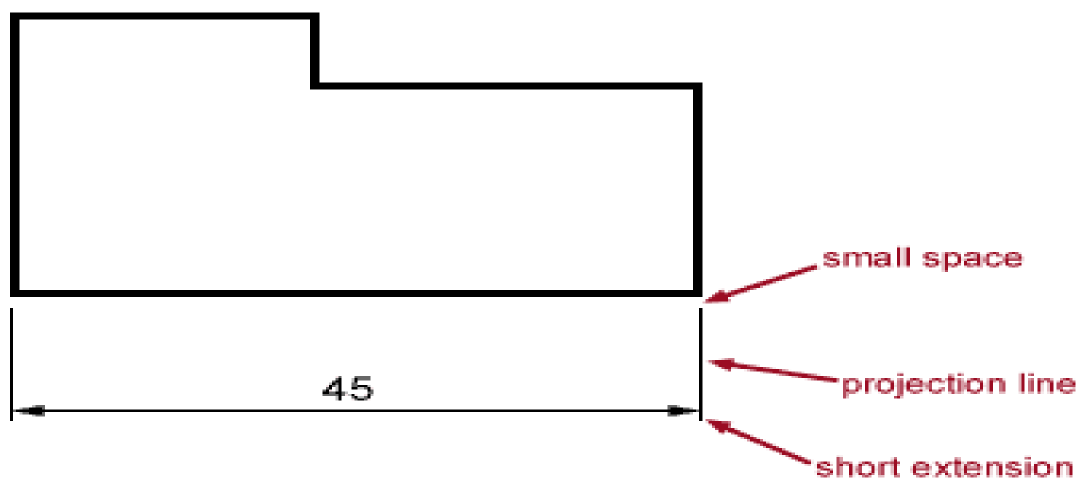


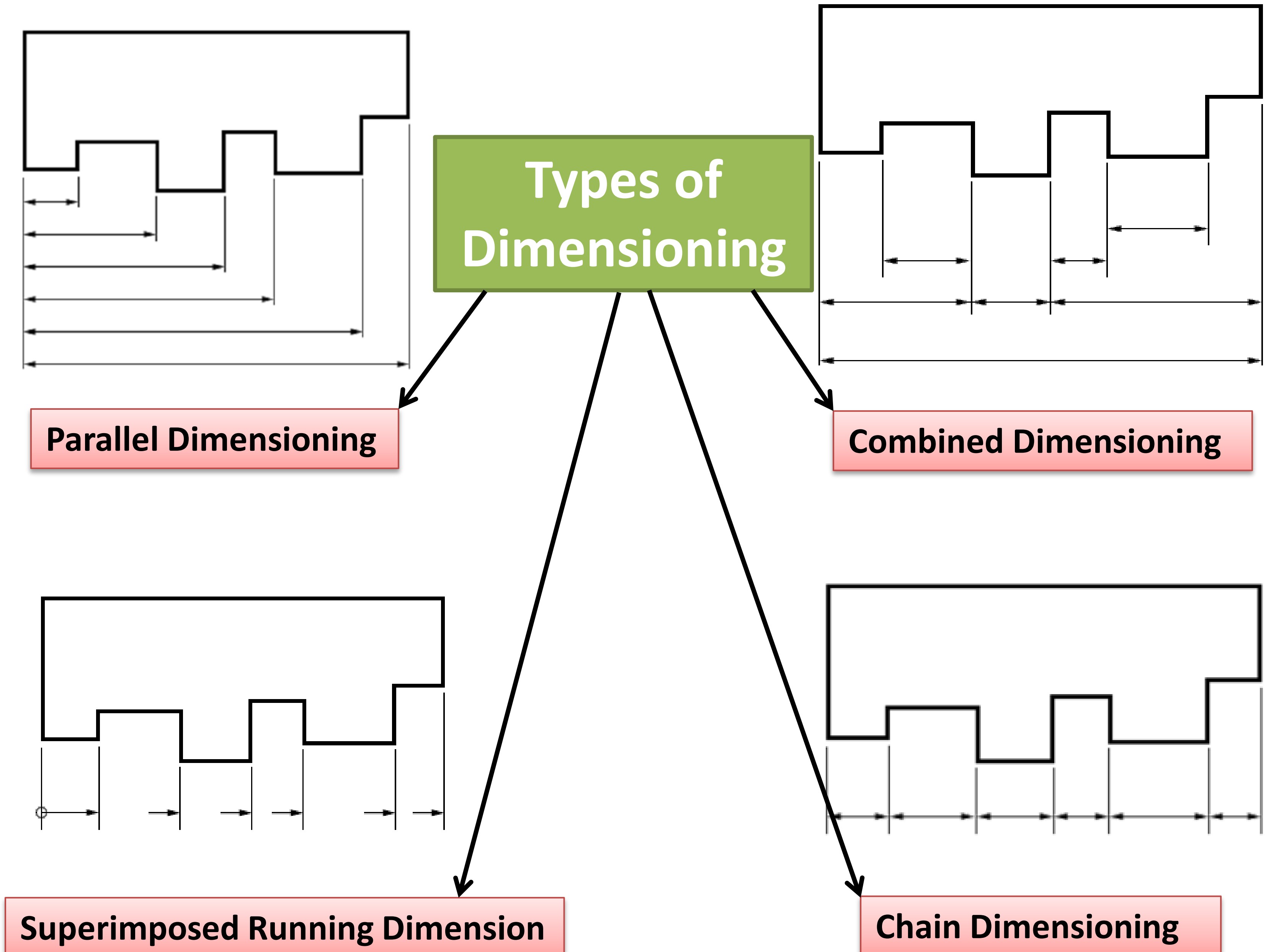
Note In isometric sketch/drawing), hidden lines are ***omitted*** unless they are absolutely necessary to completely describe the object.

Dimensioning

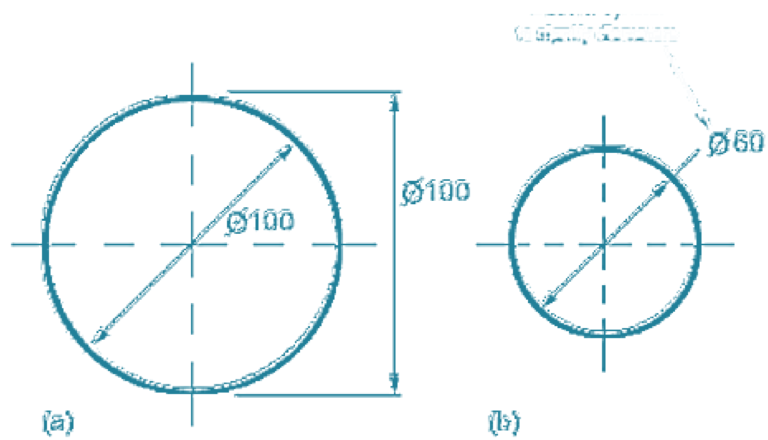
Dimensioning:

- Dimensions are always drawn using continuous thin lines.
- Two projection lines indicate where the dimension starts and finishes.
- Projection lines do not touch the object and are drawn perpendicular to the element you are dimensioning.
- All dimensions less than 1 should have a leading zero. i.e. .35 should be written as 0.35

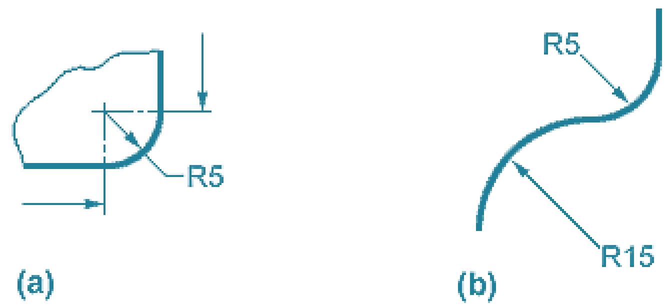



Types of Dimensioning
Parallel Dimensioning
Combined Dimensioning
Superimposed Running Dimension
Chain Dimensioning

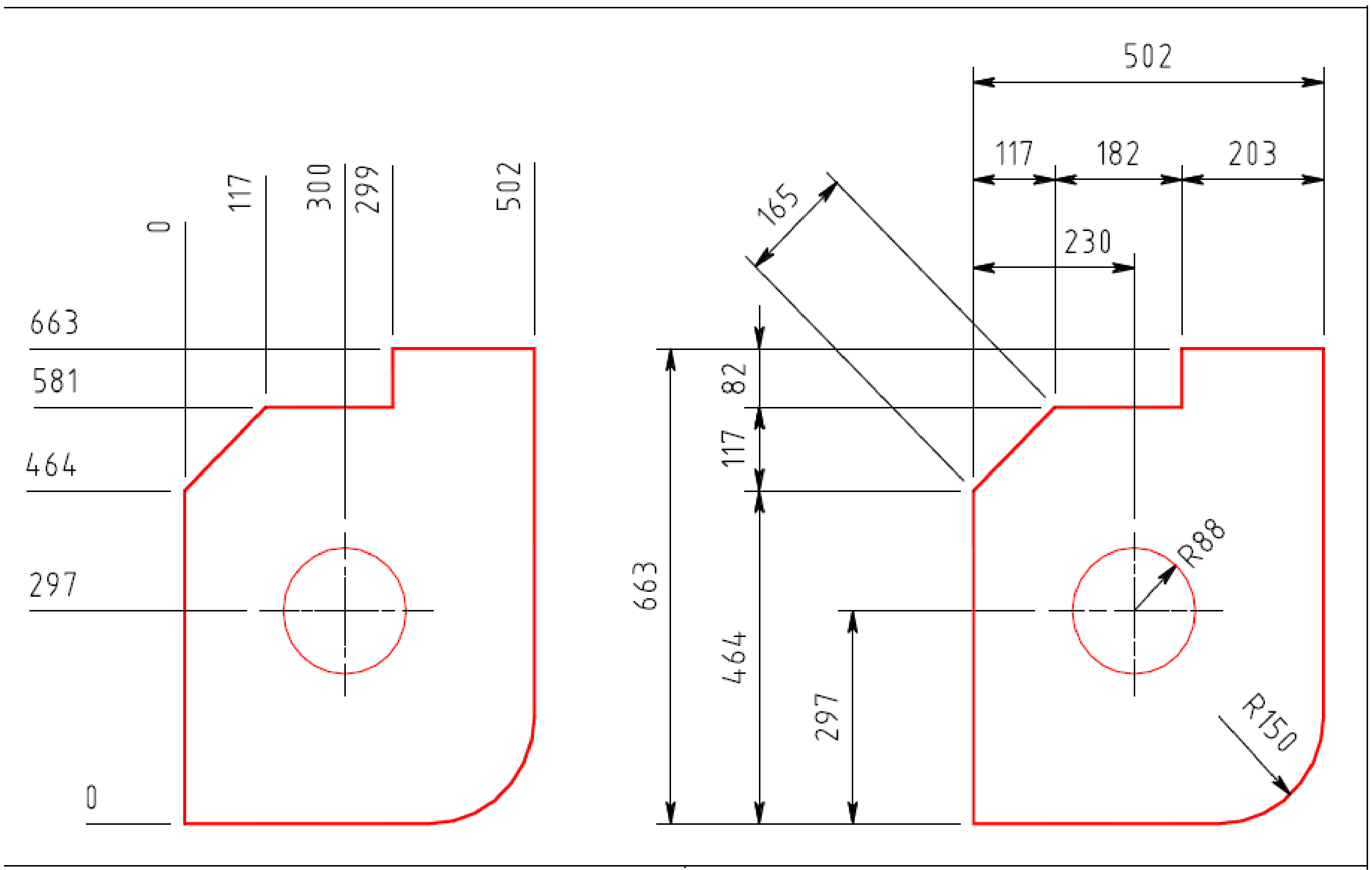
Dimensioning of Circles



Dimensioning of Radii

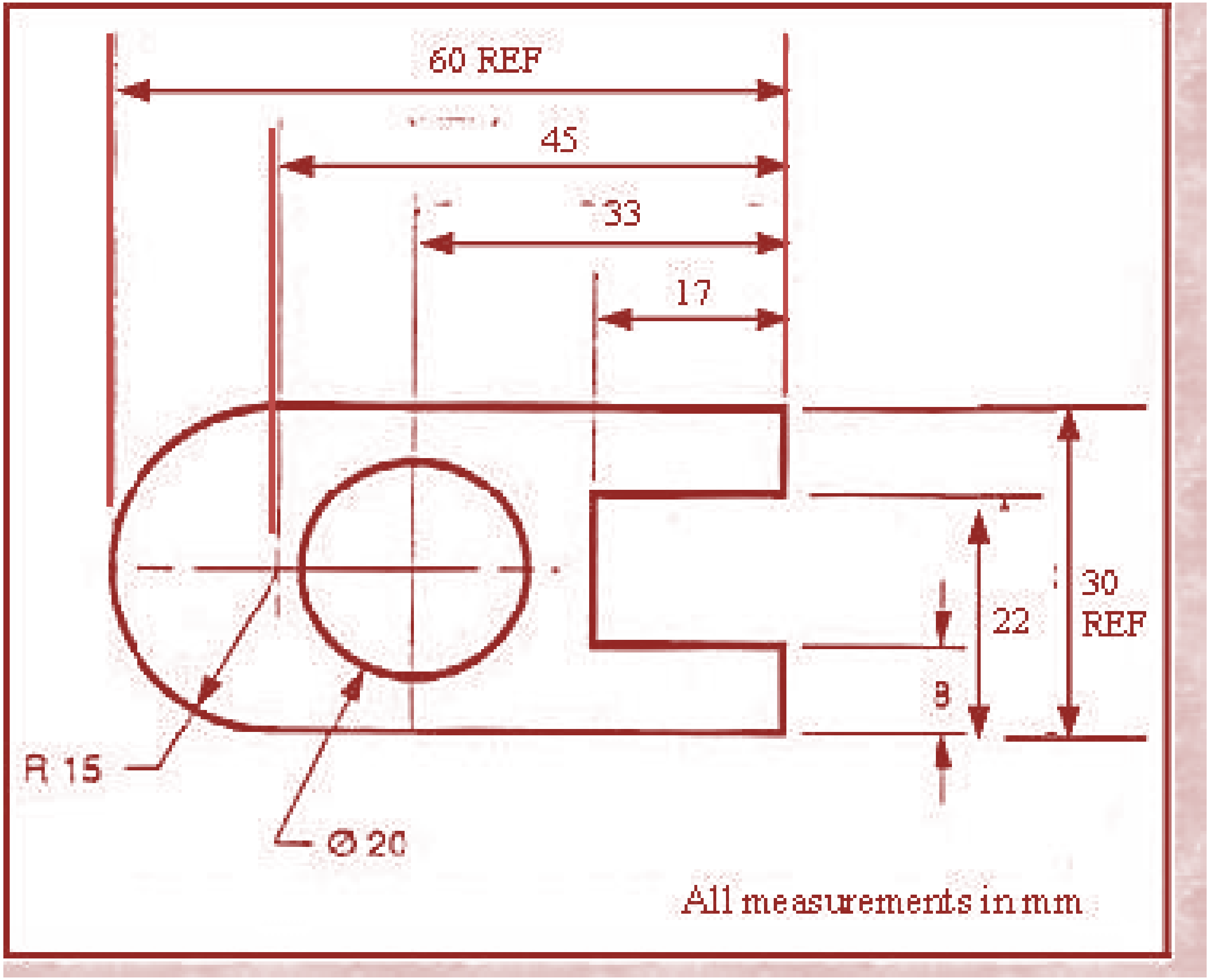


Example



Incorrect

Correct


60 REF
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R 15
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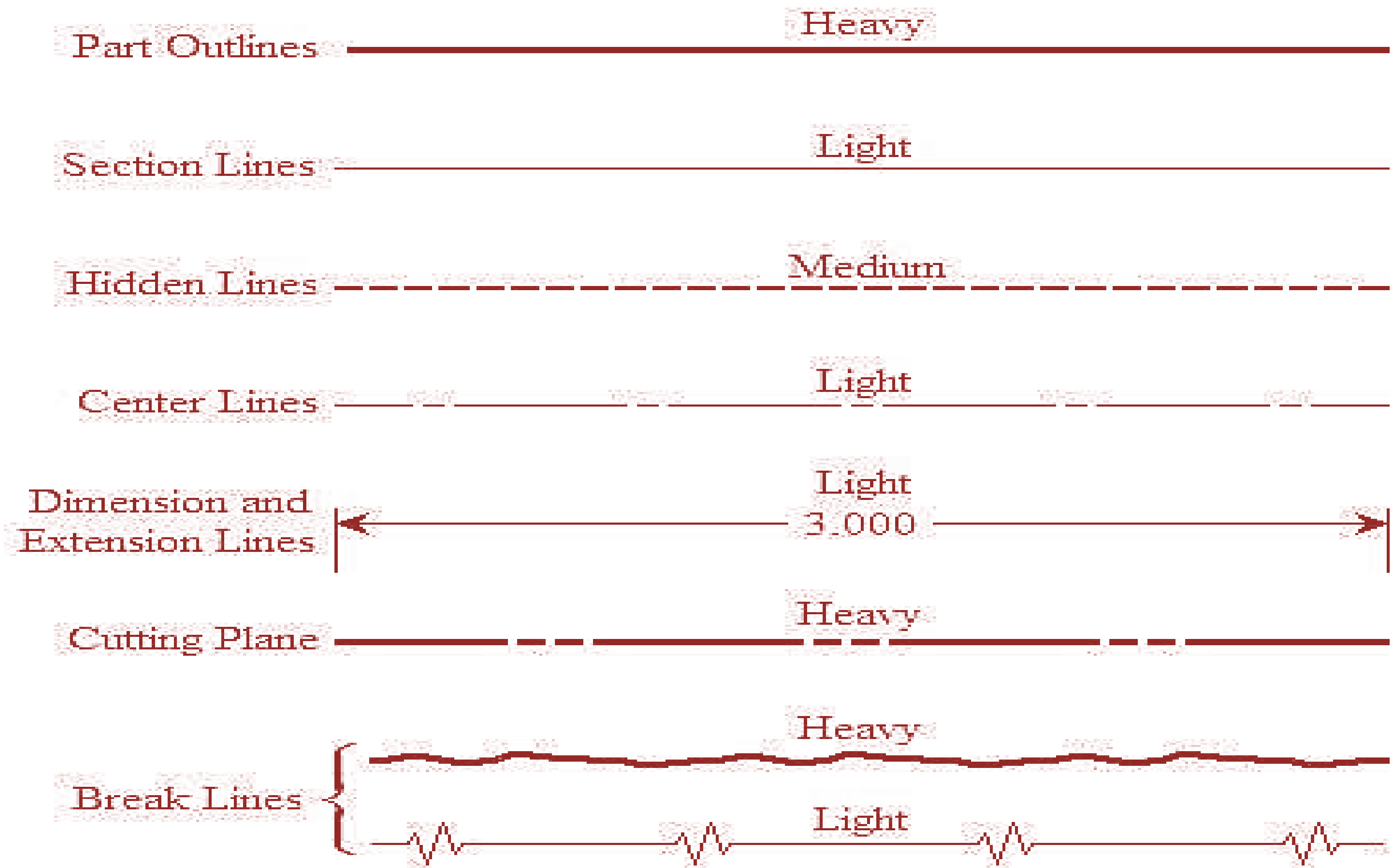
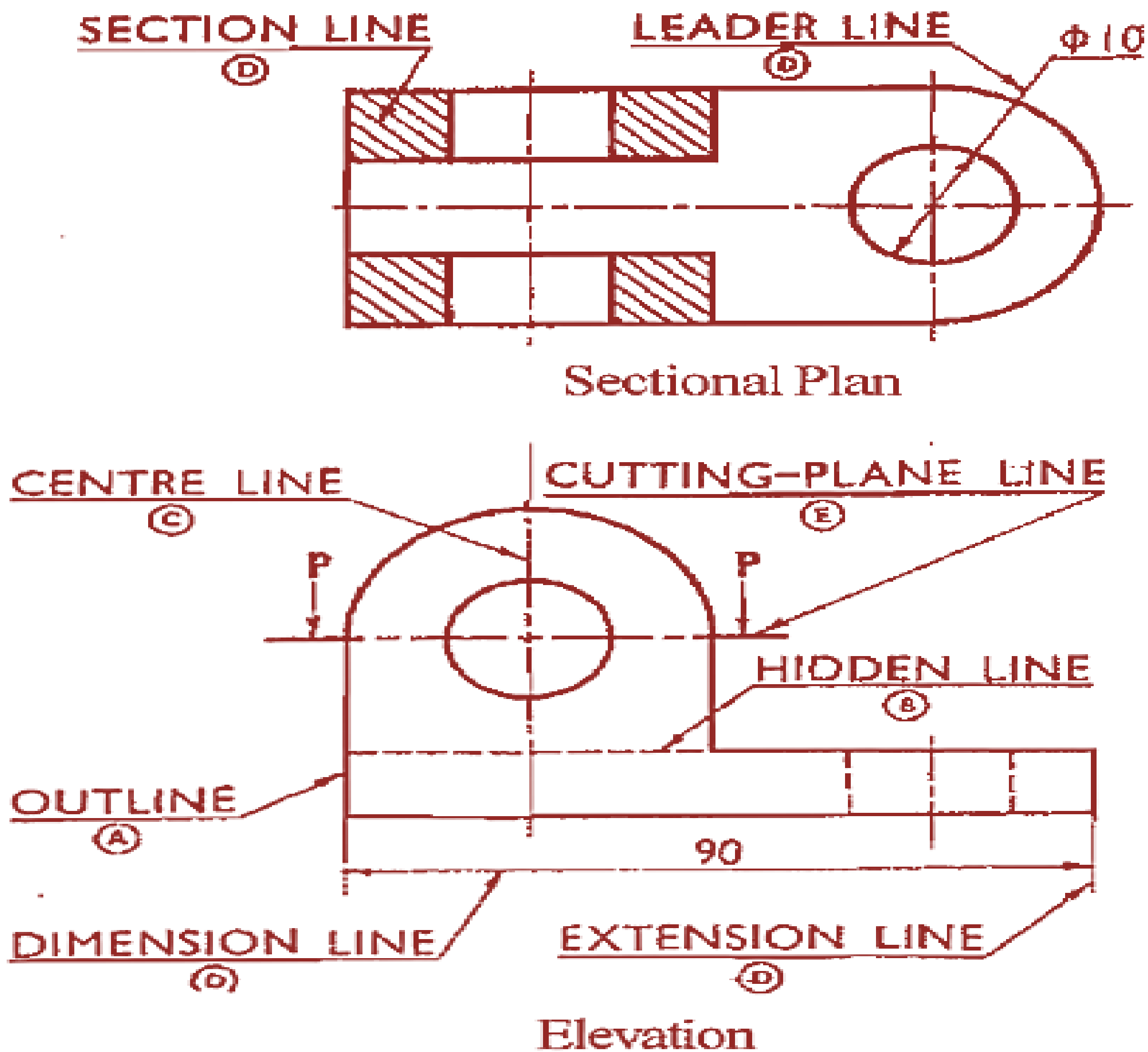
All measurements in mm

<u>Different types of lines:</u>

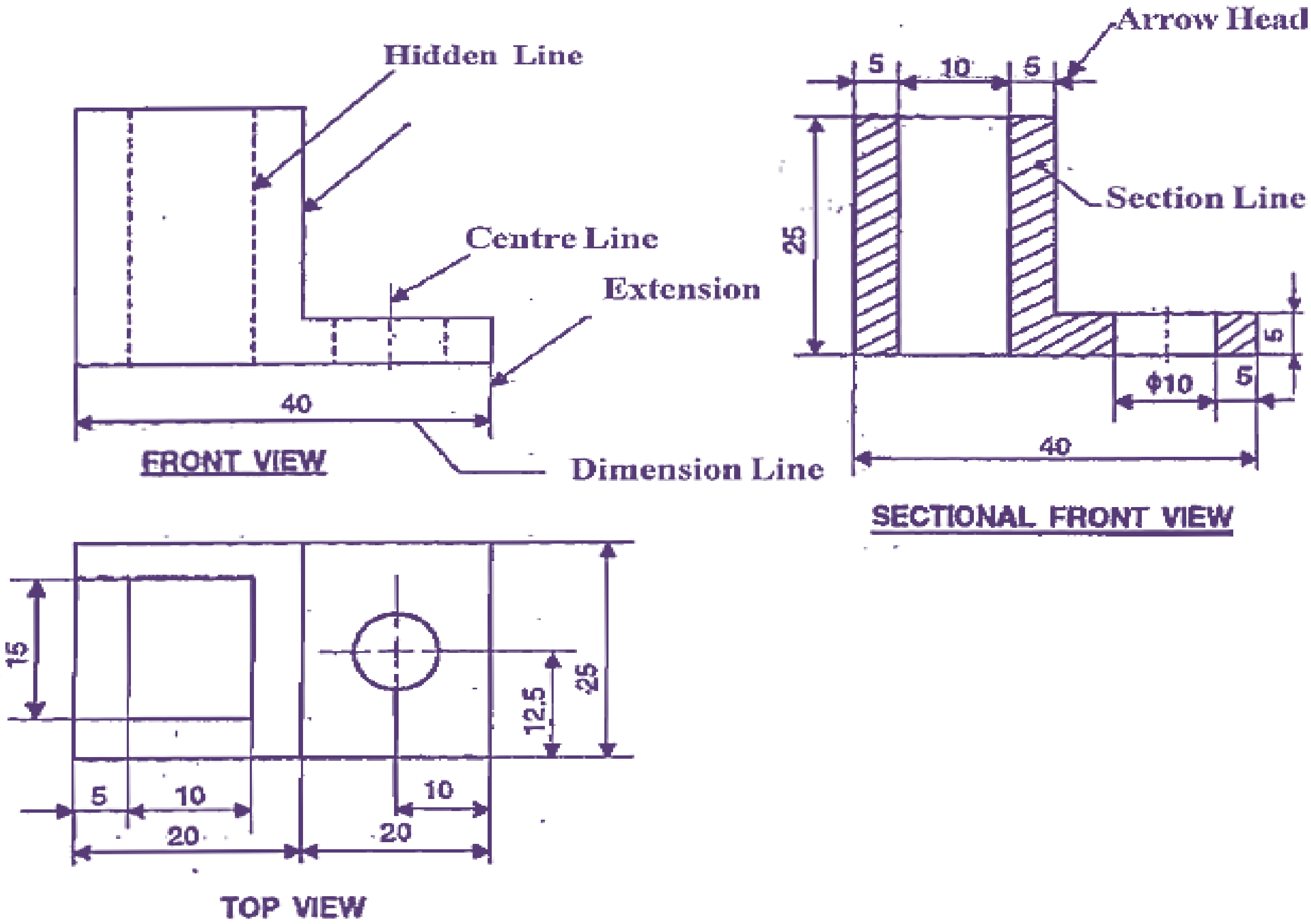
In engineering drawing several lines are followed to define a shape of the object. Each & every line has it’s individual line and shape.



View of Different types of line:



View of Different types of line:



Some Isometric Views

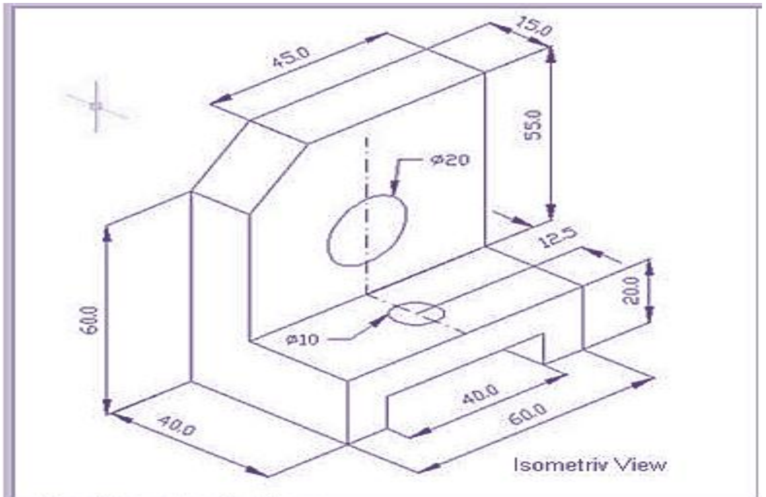
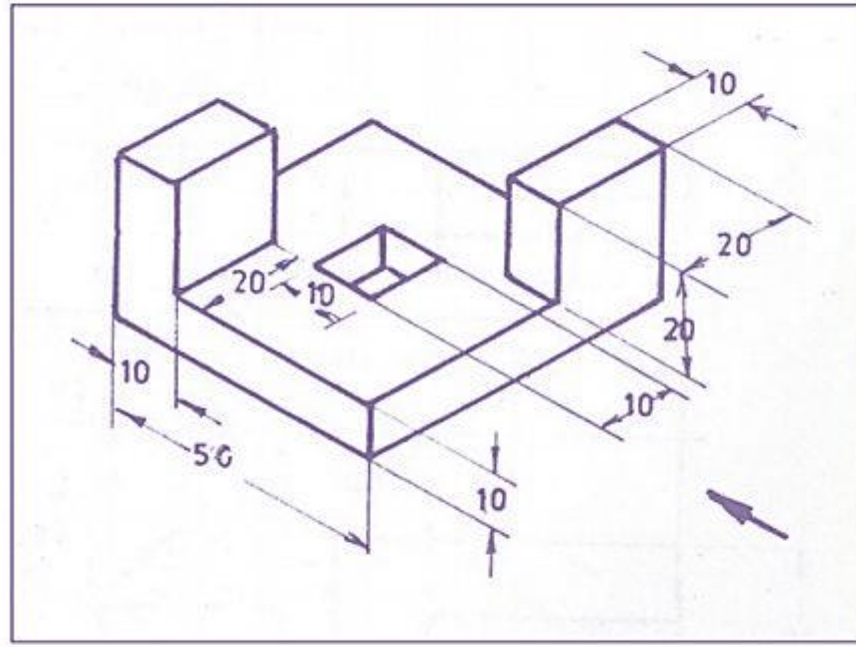
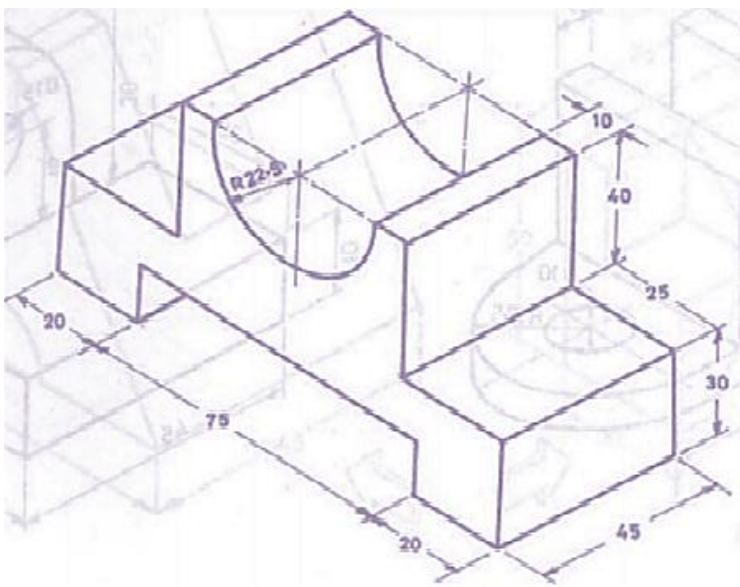
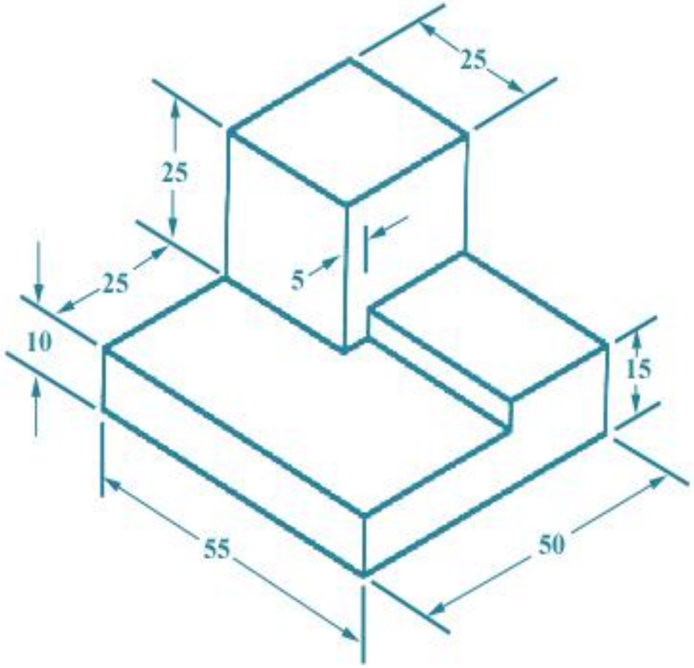


Fig. 3: Isometric View



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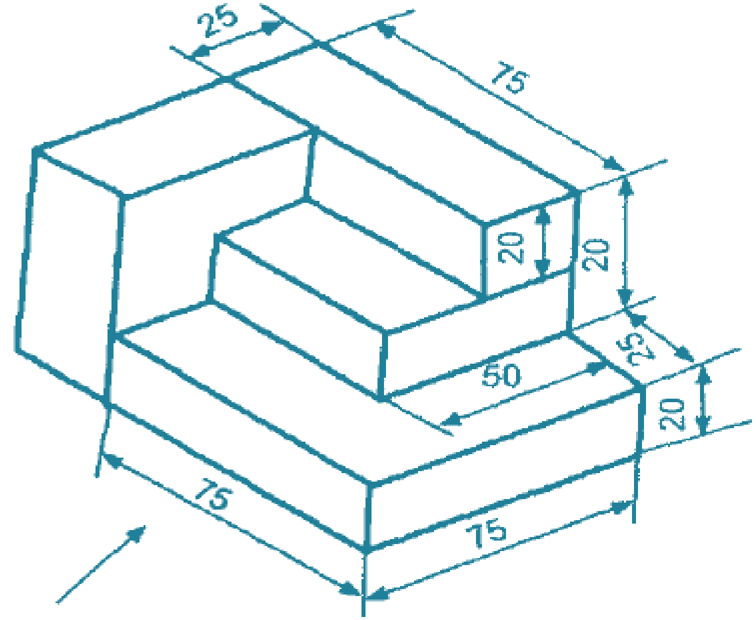
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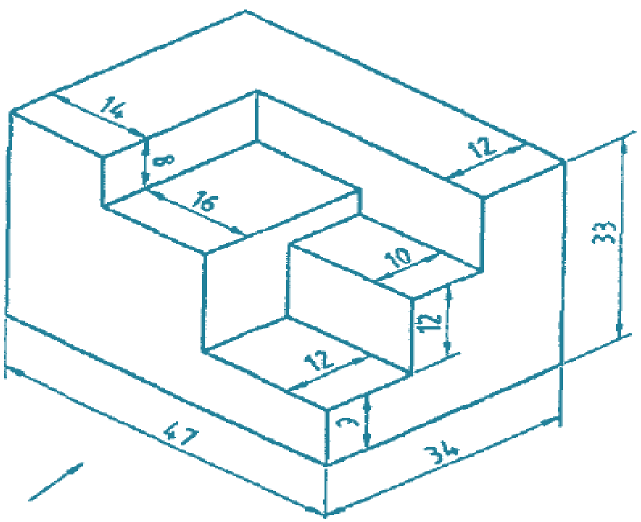
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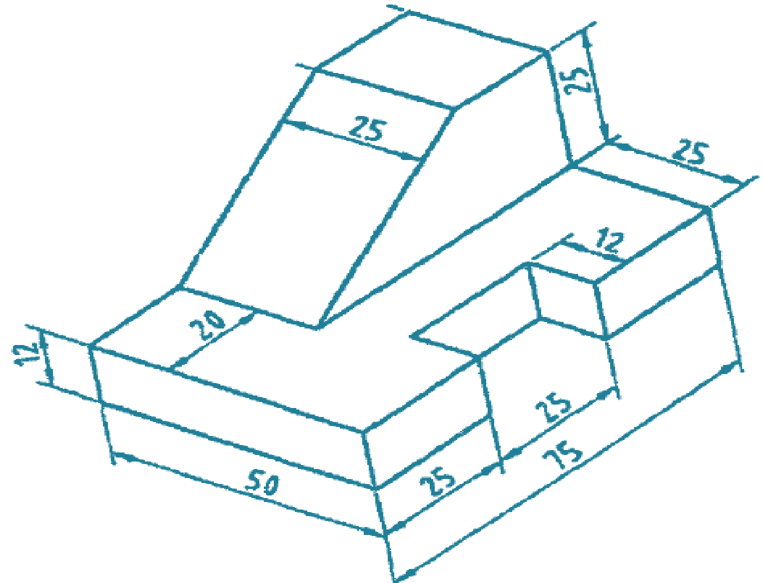
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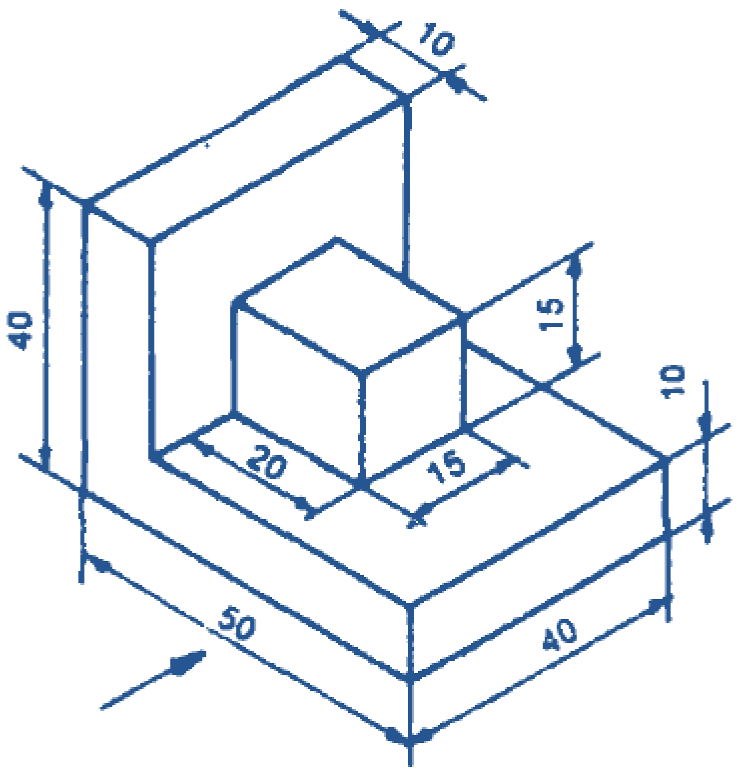
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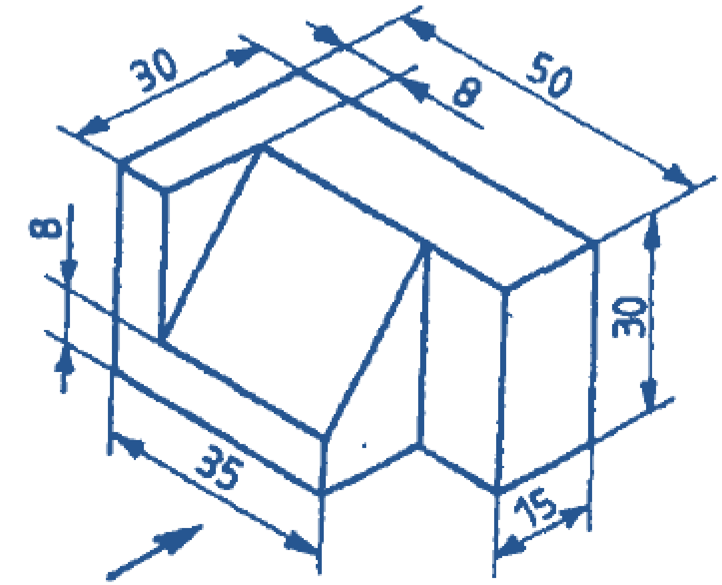
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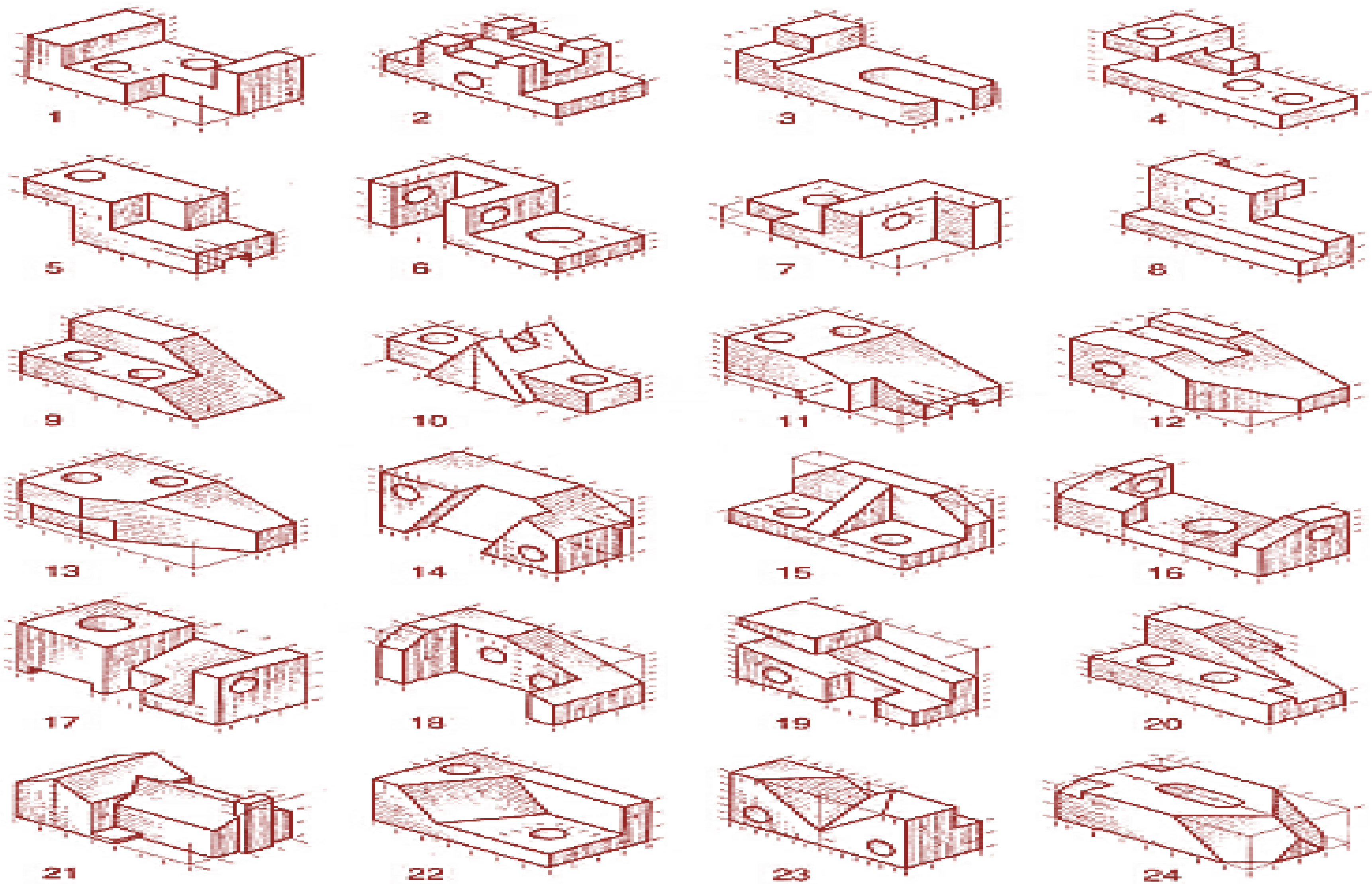
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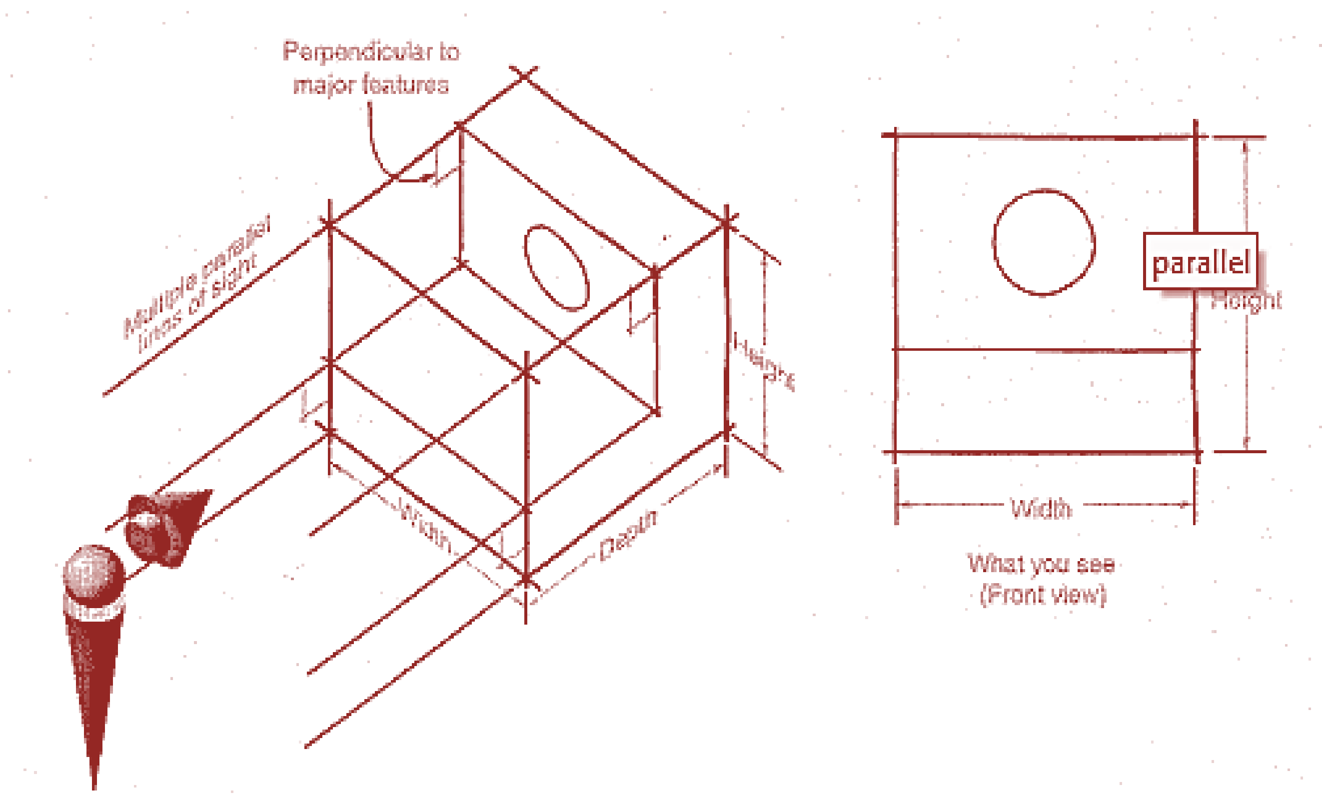
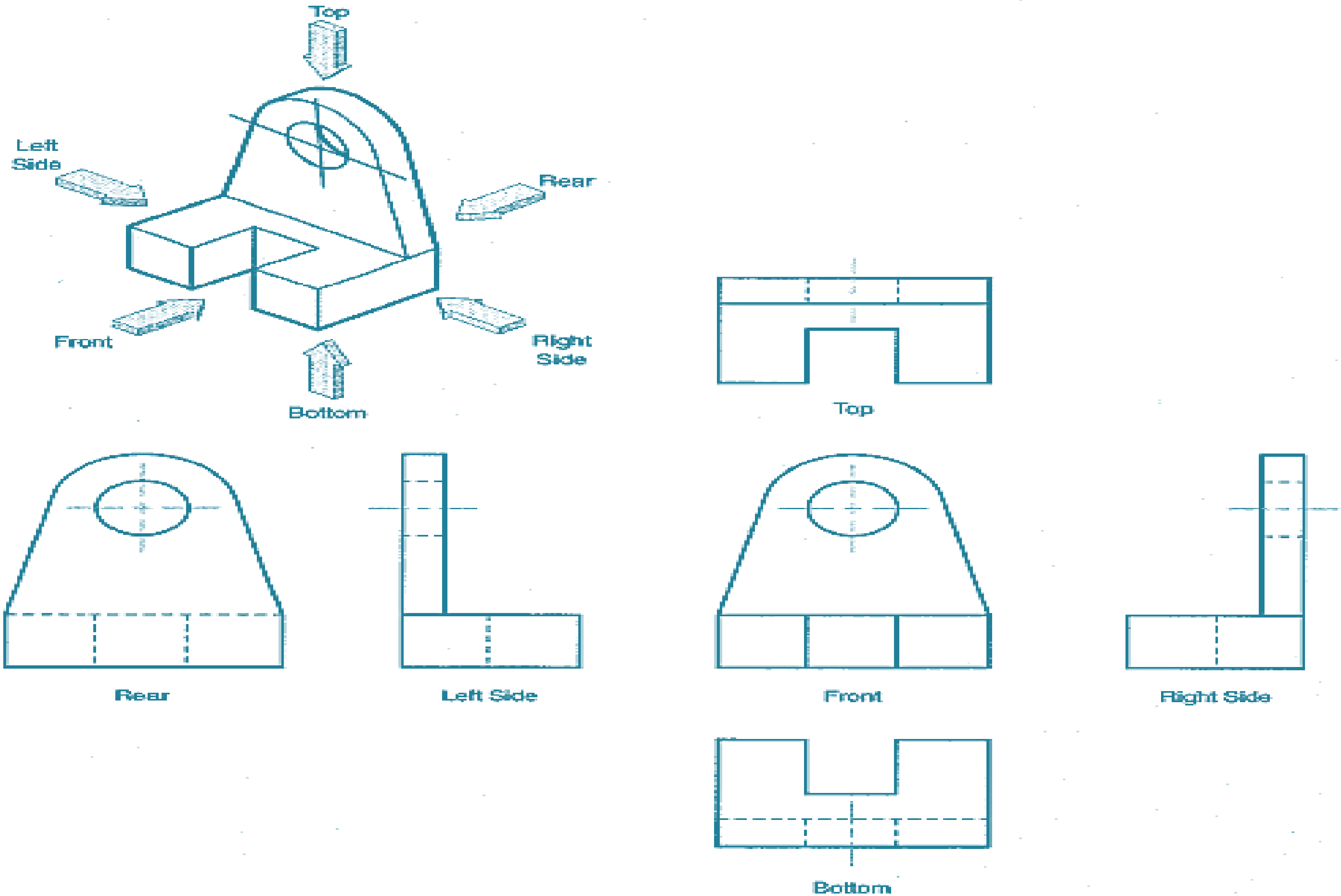
Orthographic View

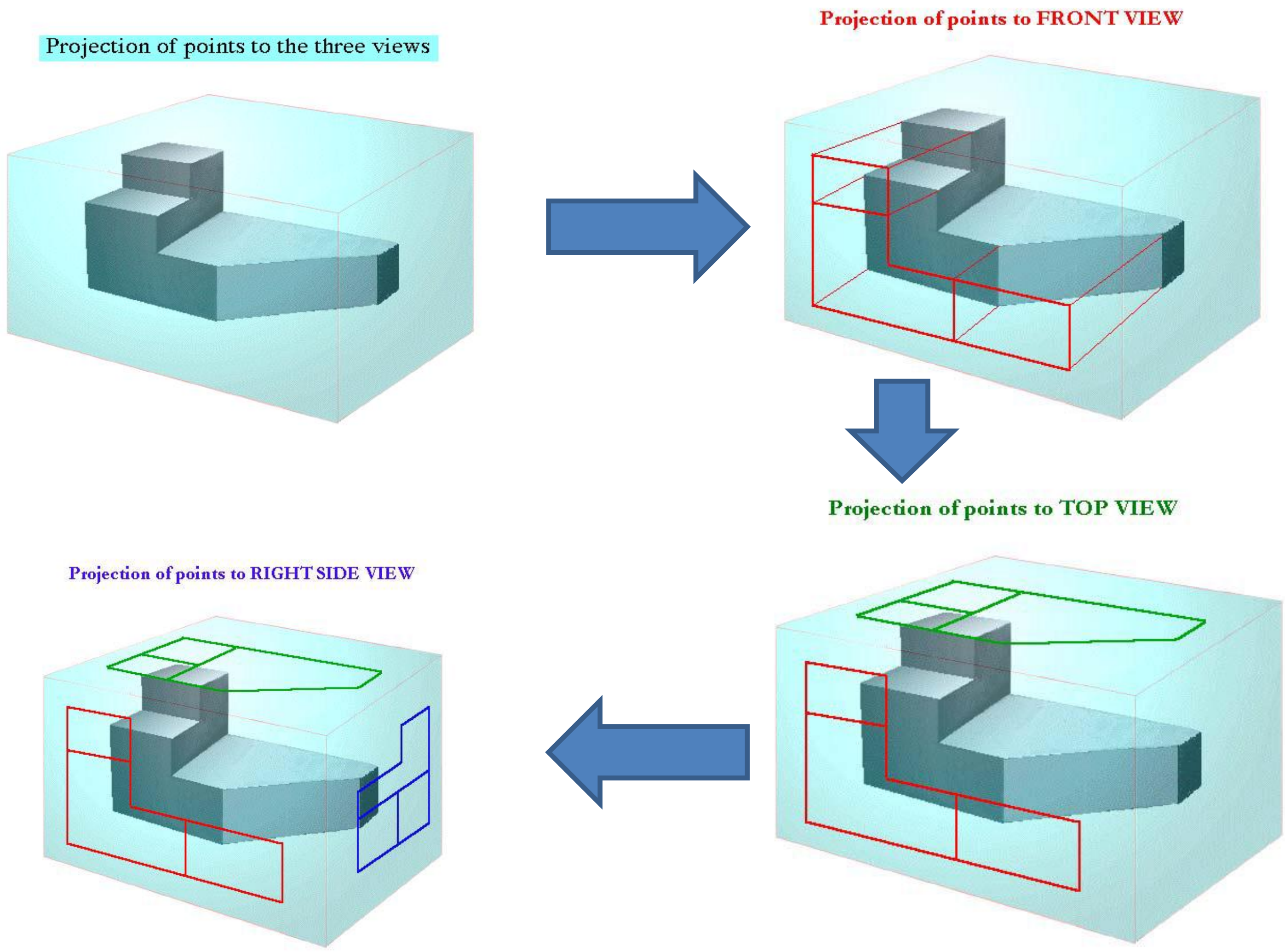


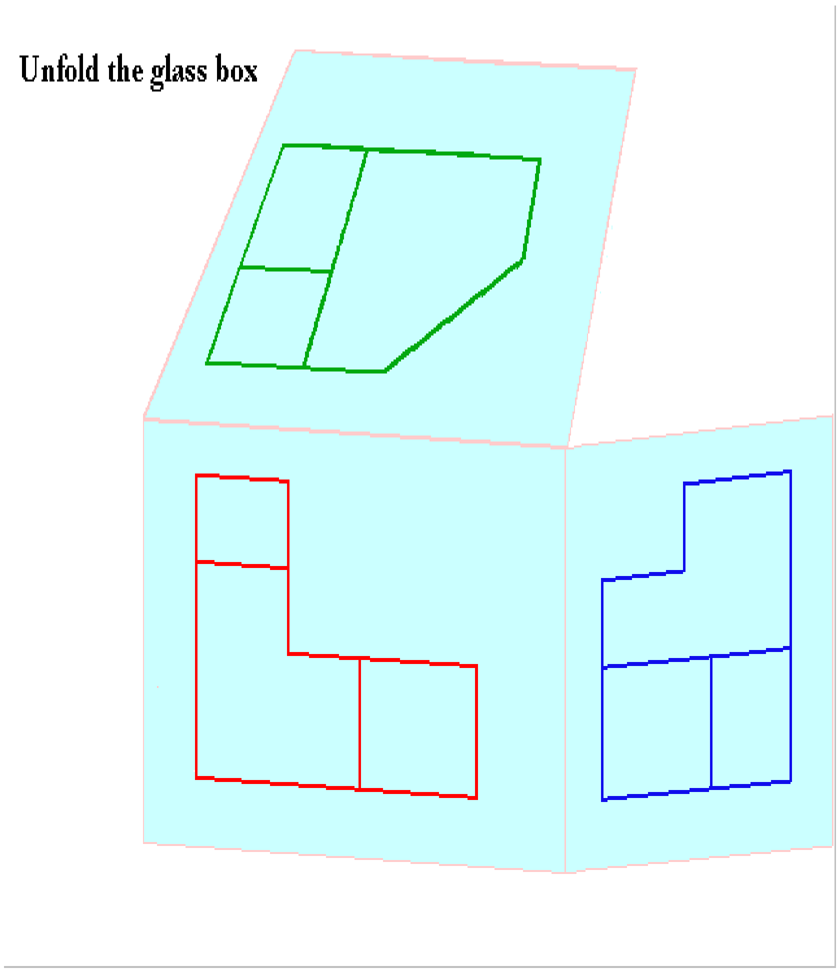
- Orthographic Projections are a collection of 2-D drawings that work together to give an accurate overall representation of an object.

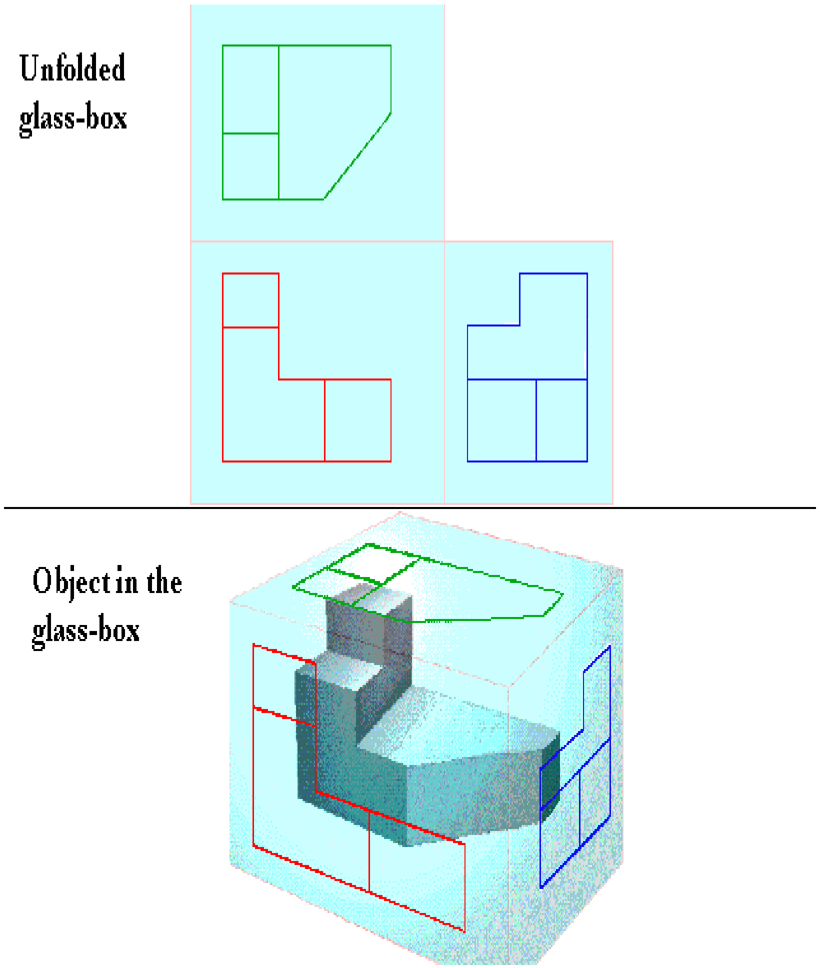
Defining the Six Principal Views or Orthographic Views:



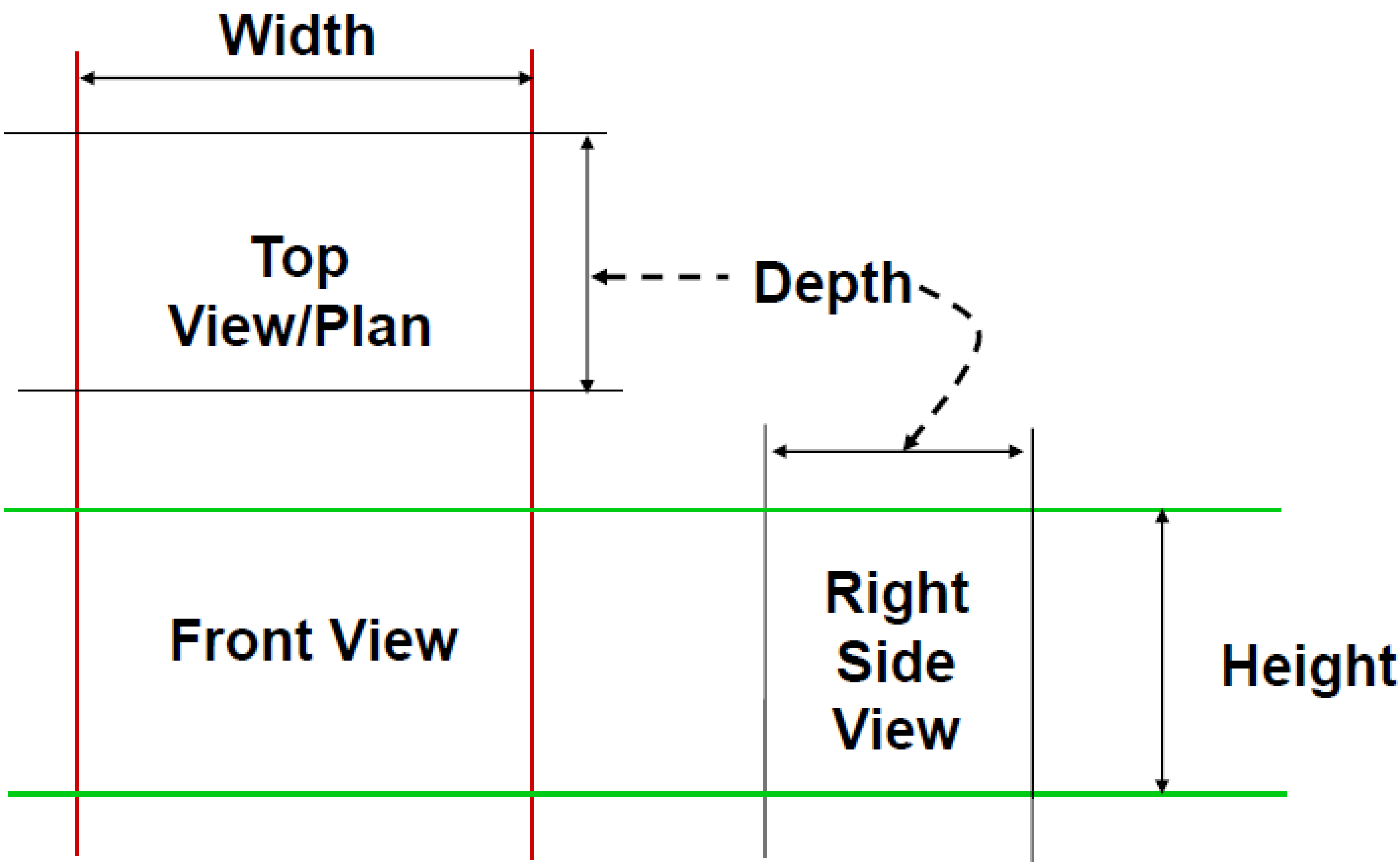
Glass Box Approach:



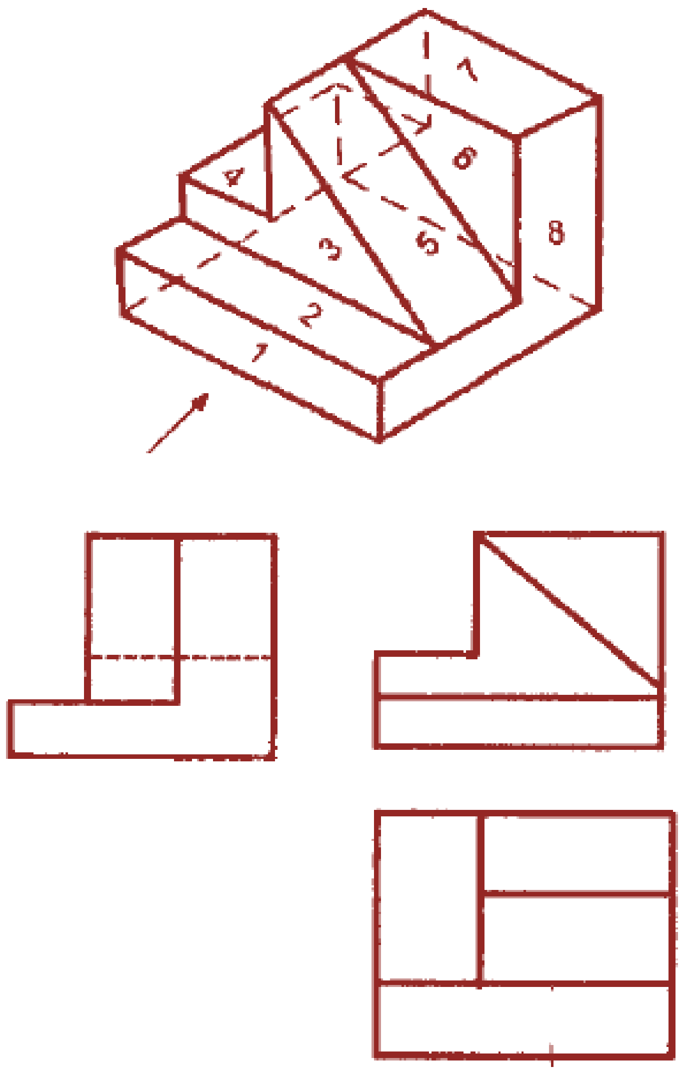

Unfold the glass box


Unfolded
glass-box
Object in the
glass-box

Conventional Orthographic Views:



Examples for Drawing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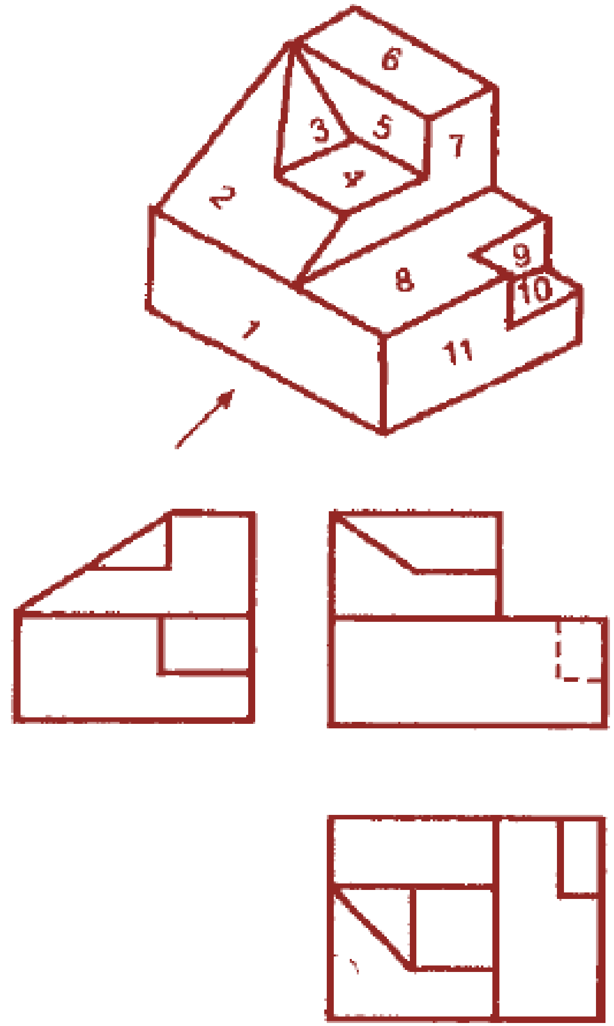
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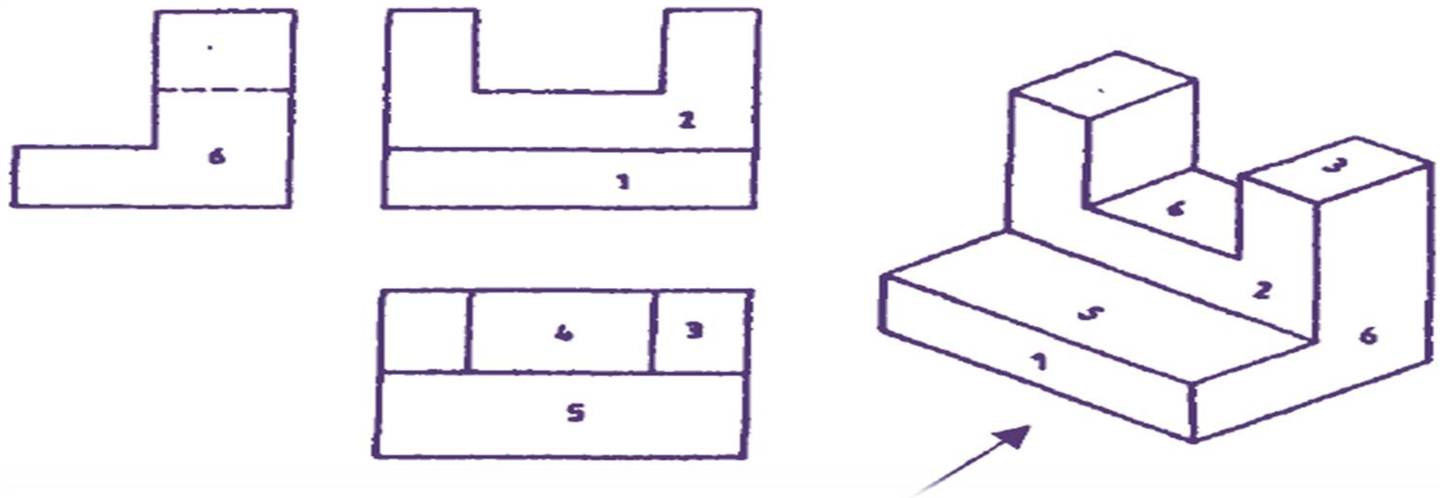
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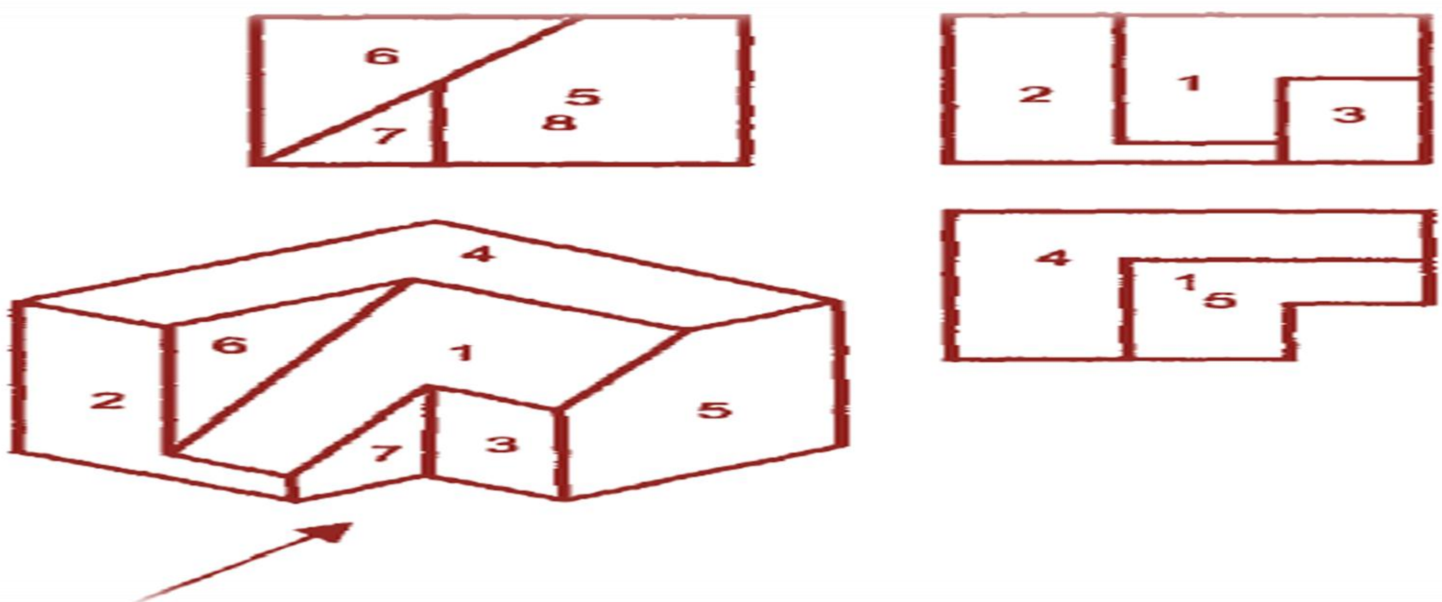
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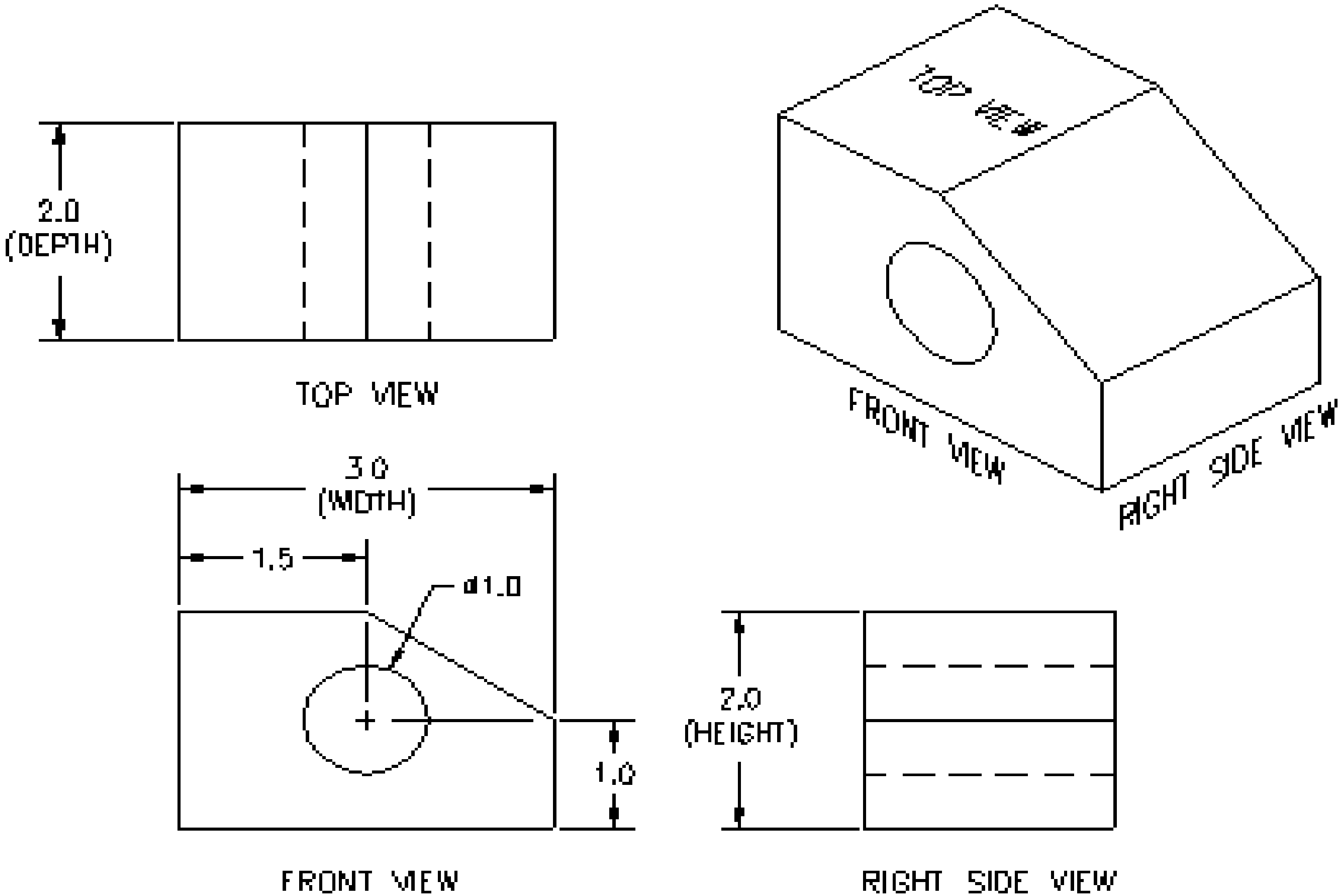
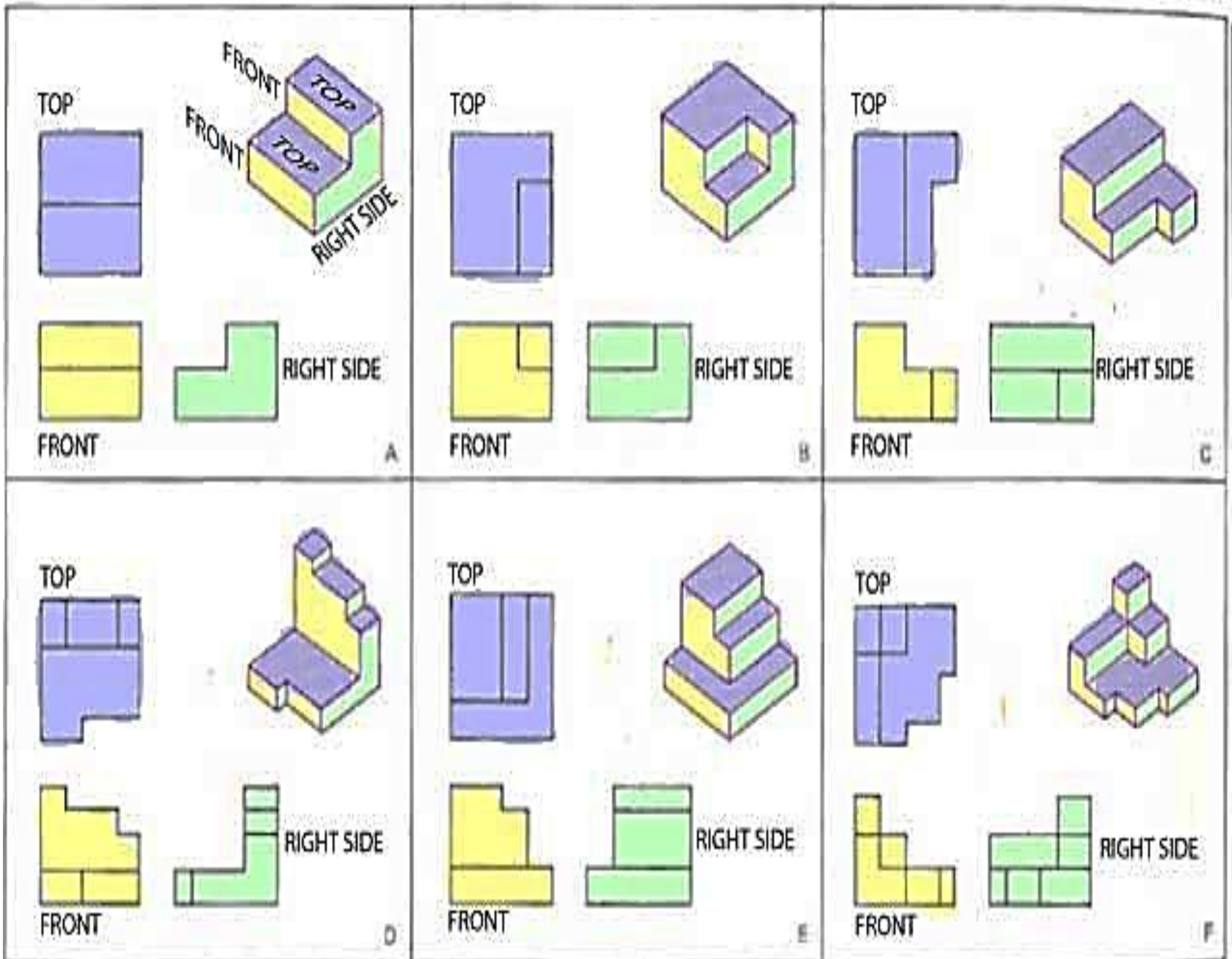

2.0
(DEPTH)
TOP VIEW
TOP VIEW
FRONT VIEW
RIGHT SIDE VIEW
3.0
(WIDTH)
1.5
d1.0
1.0
2.0
(HEIGHT)
FRONT VIEW
RIGHT SIDE VIEW


TOP
FRONT
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FRONT
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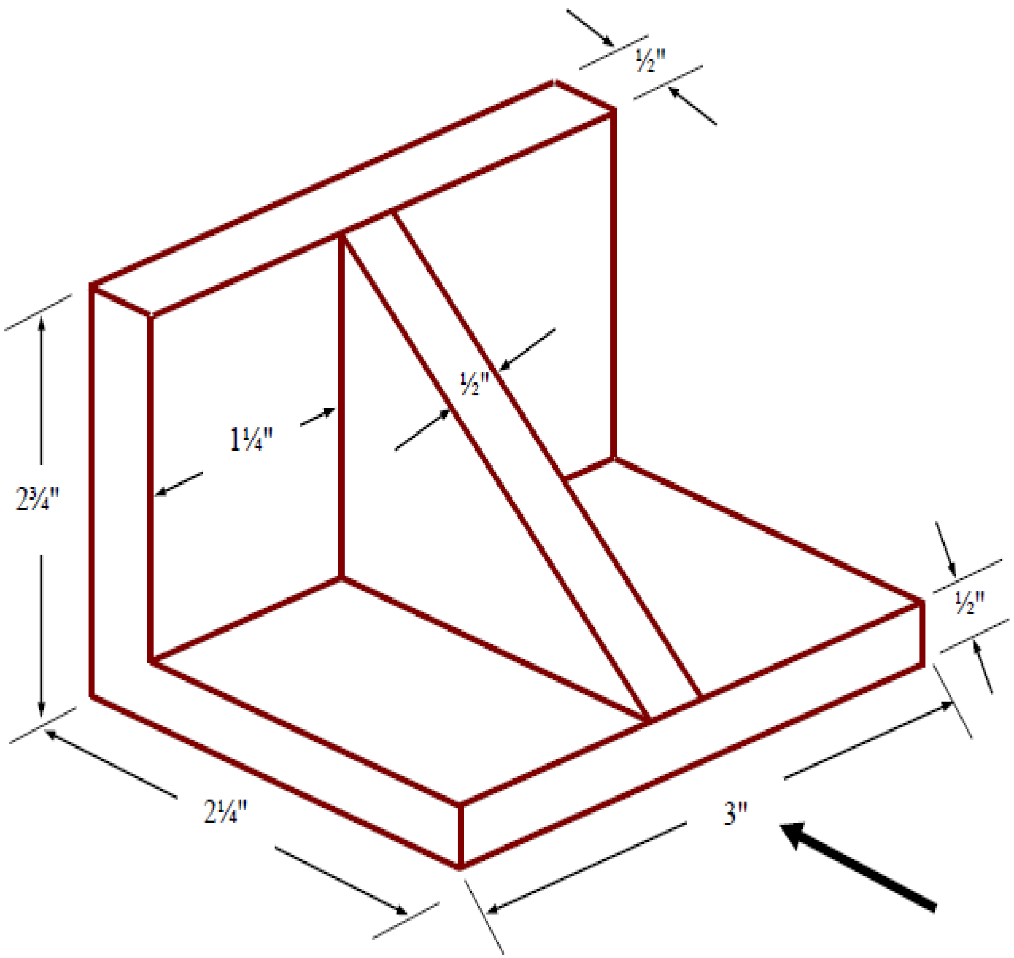
F


½"
½"
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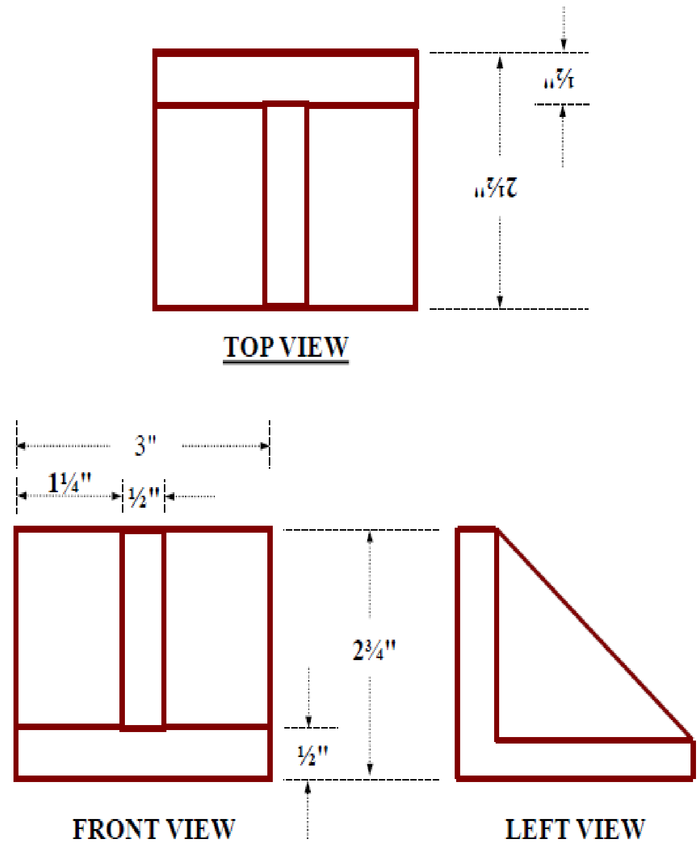

½"
2¼"
TOP VIEW
3"
1¼"
½"
2¾"
½"
FRONT VIEW
LEFT VIEW

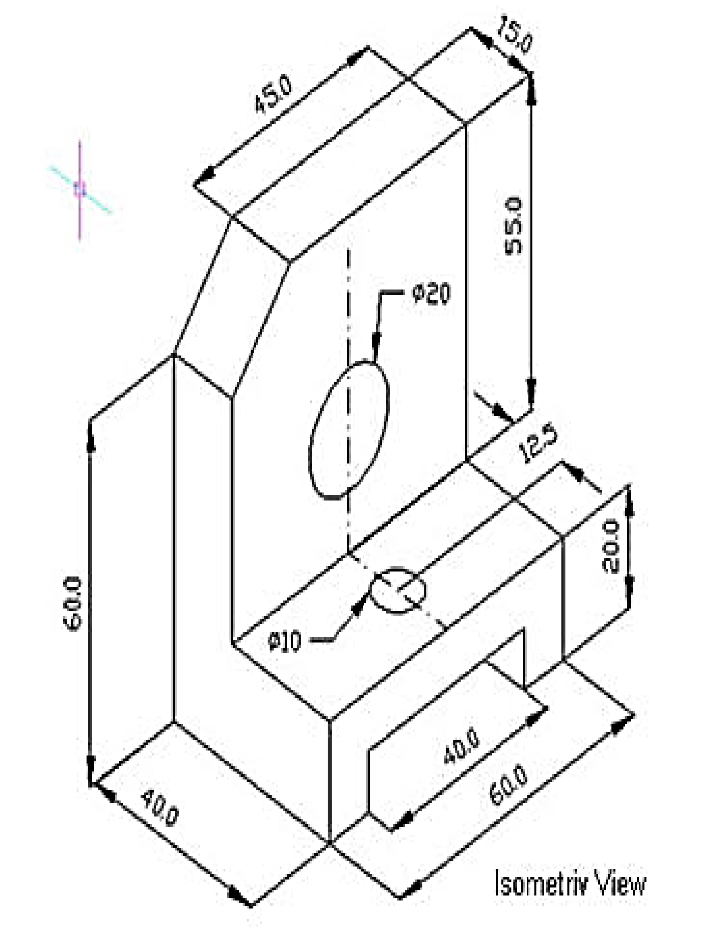


Fig. 3: Isometric View

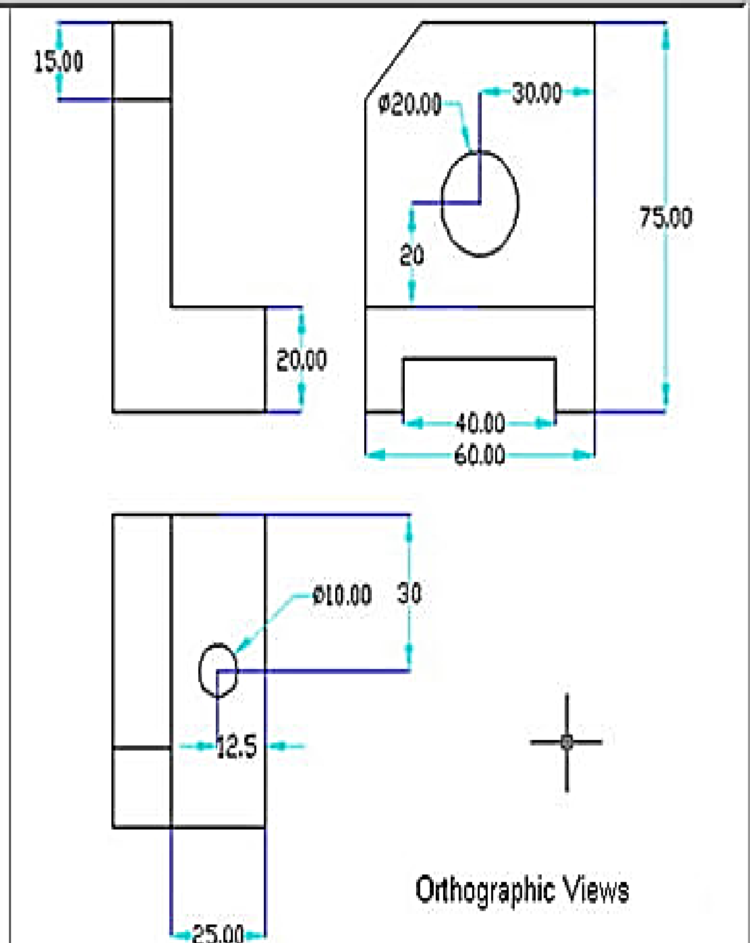
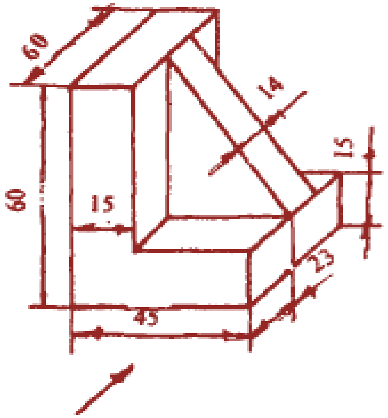


Fig. 4: Orthographic views


60
60
14
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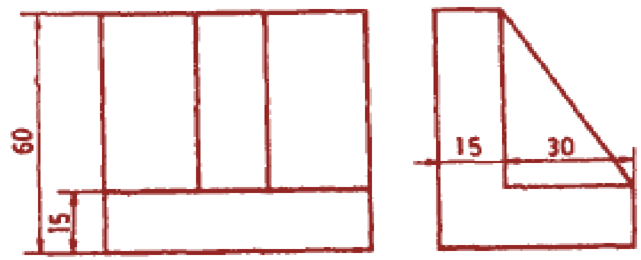
45
23

(a)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(b)

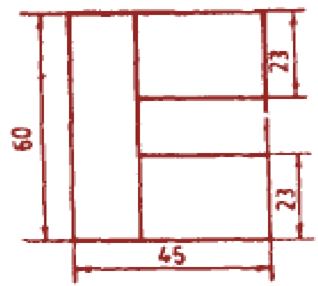
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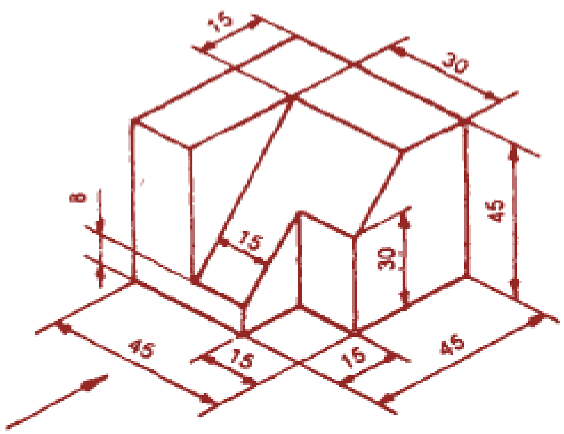
Fig : 1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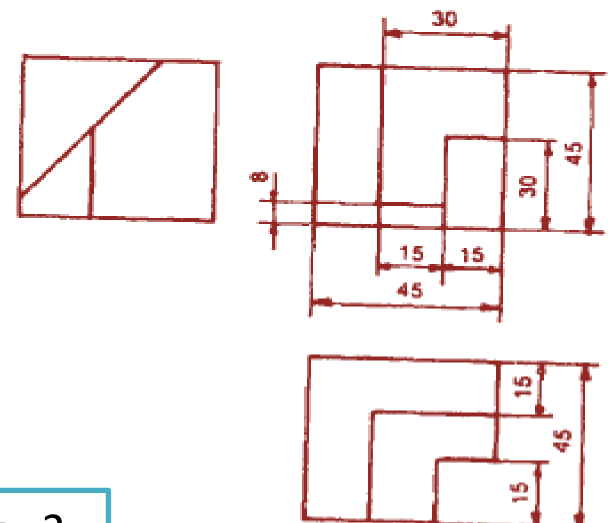
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Fig : 2

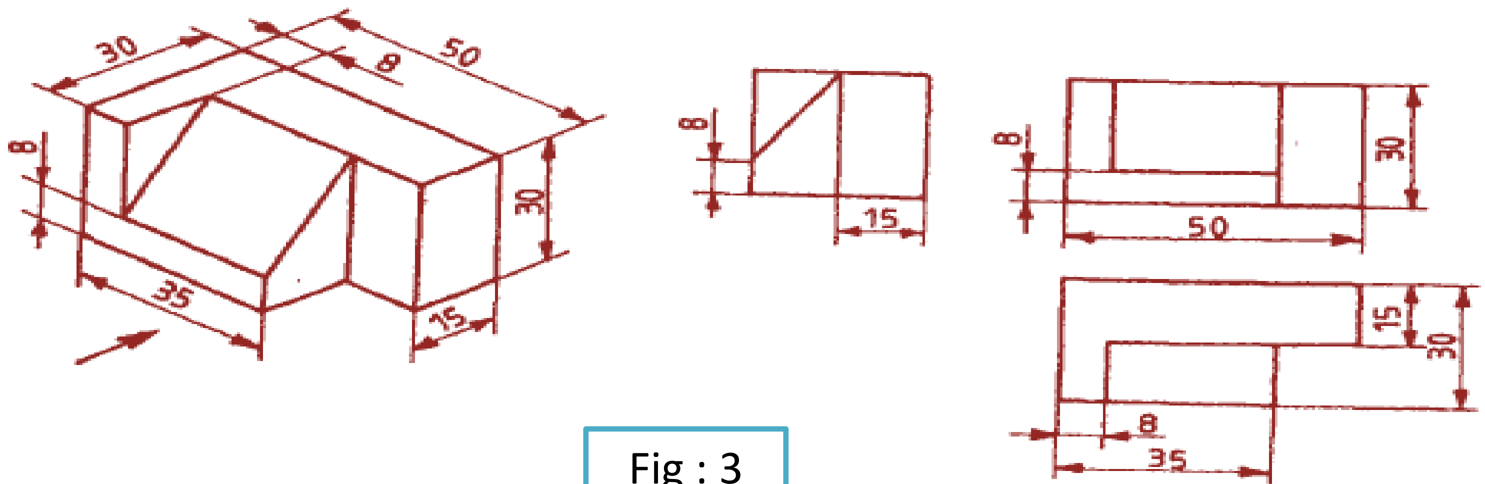

Fig : 3

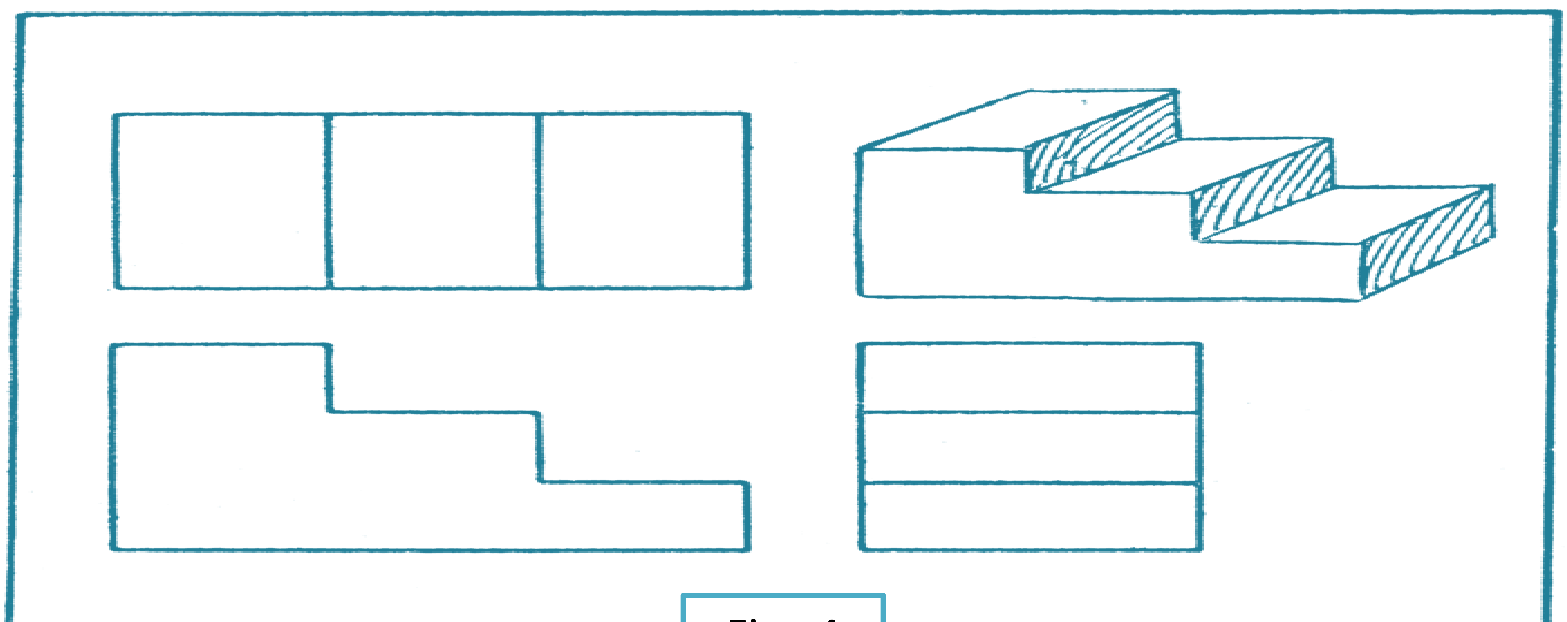

Fig : 4

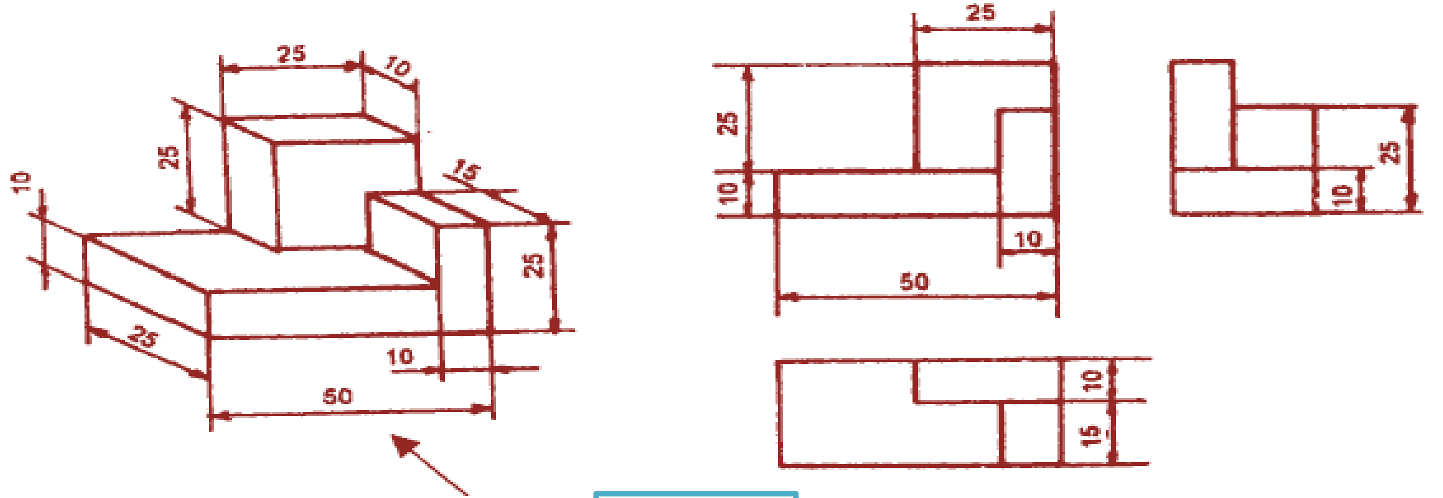
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Fig : 5

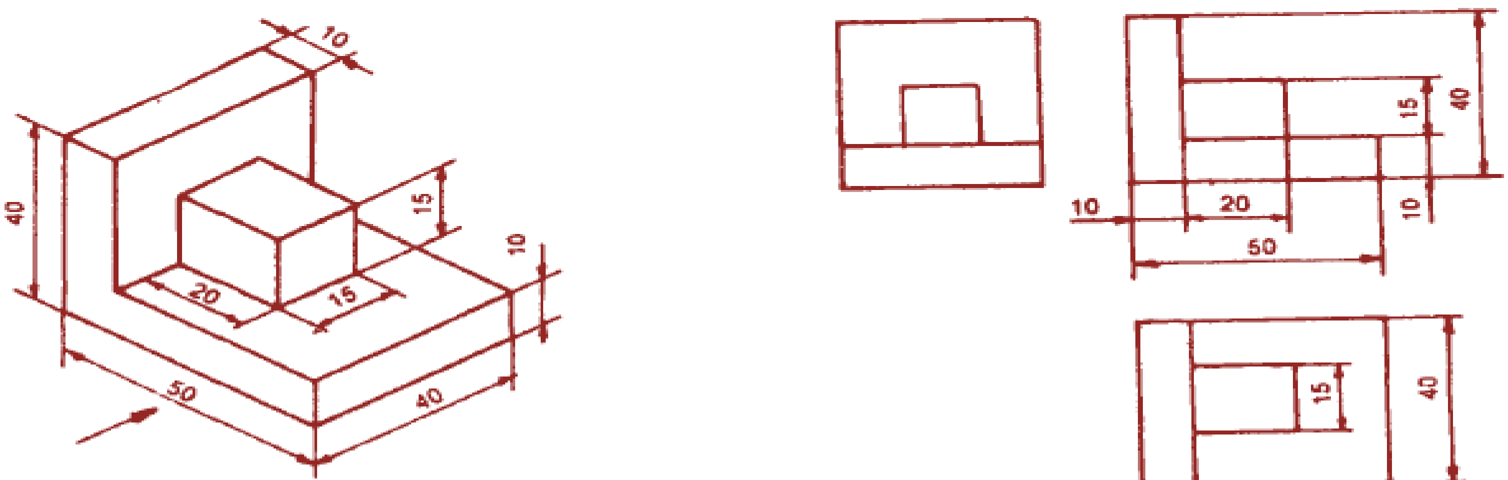
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Fig : 6

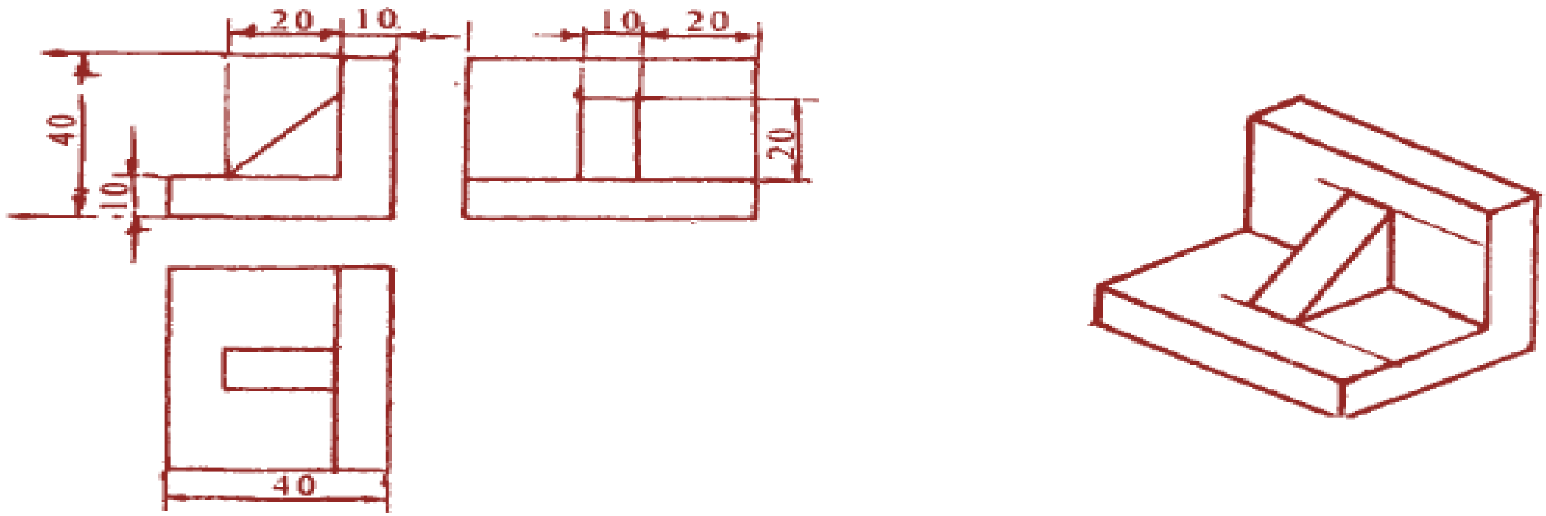
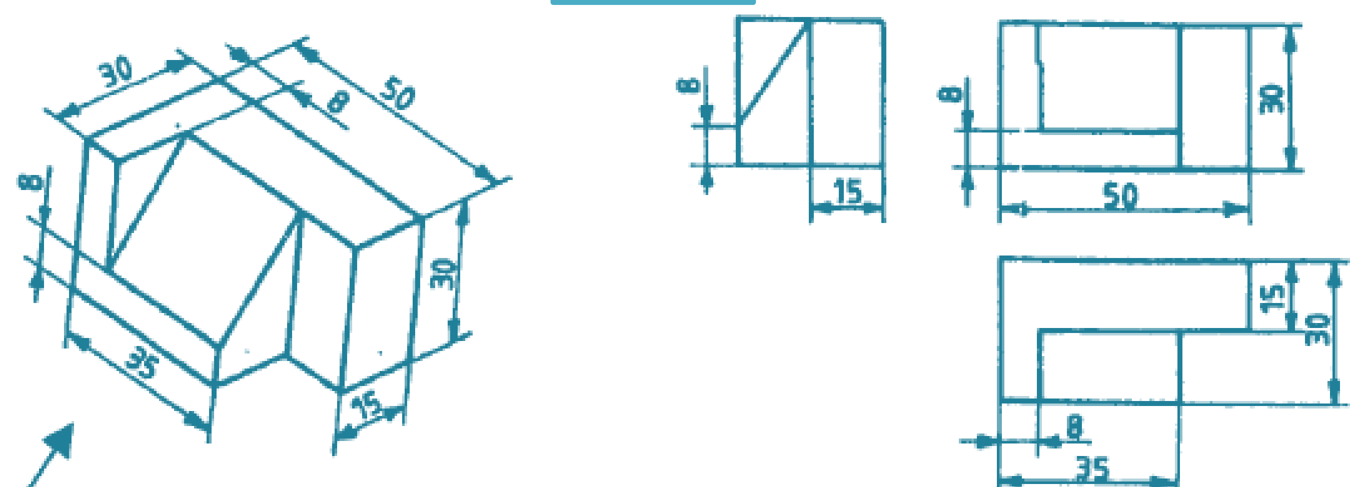
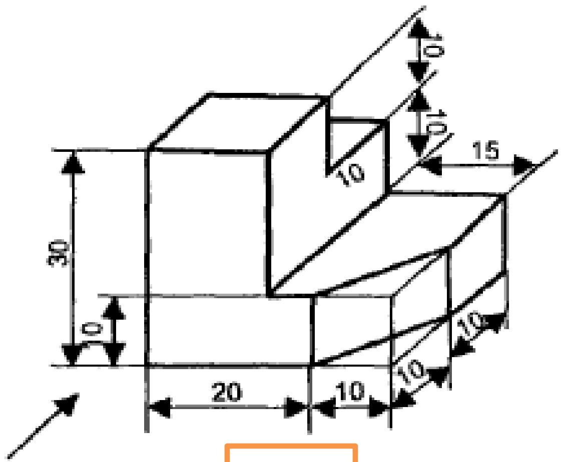


Fig : 7

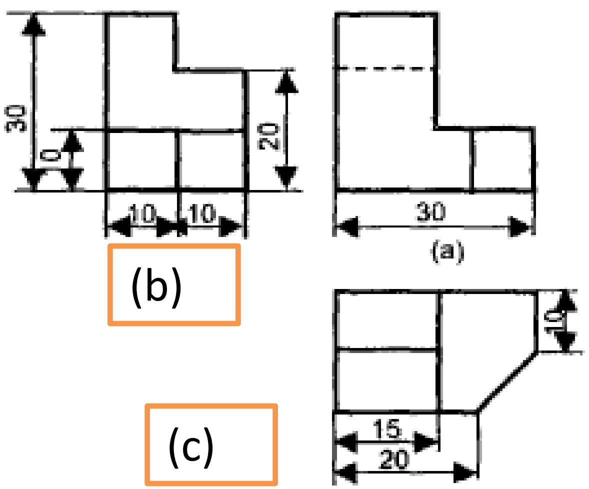


(a) (b)

Fig : 8



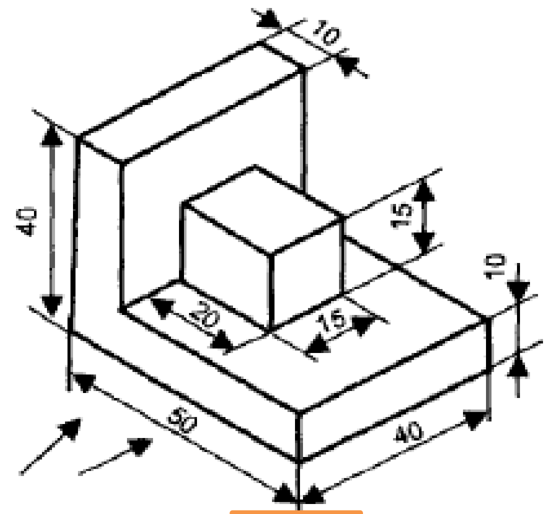
(a)



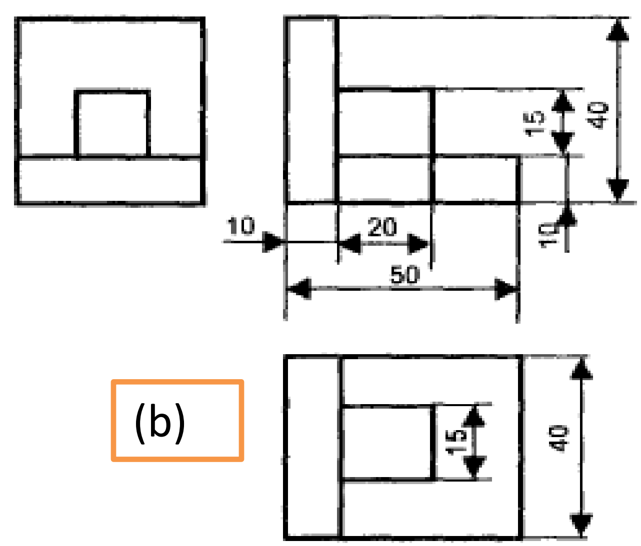
(b)

(c)

Fig : 9



(a)



(b)

Fig : 10

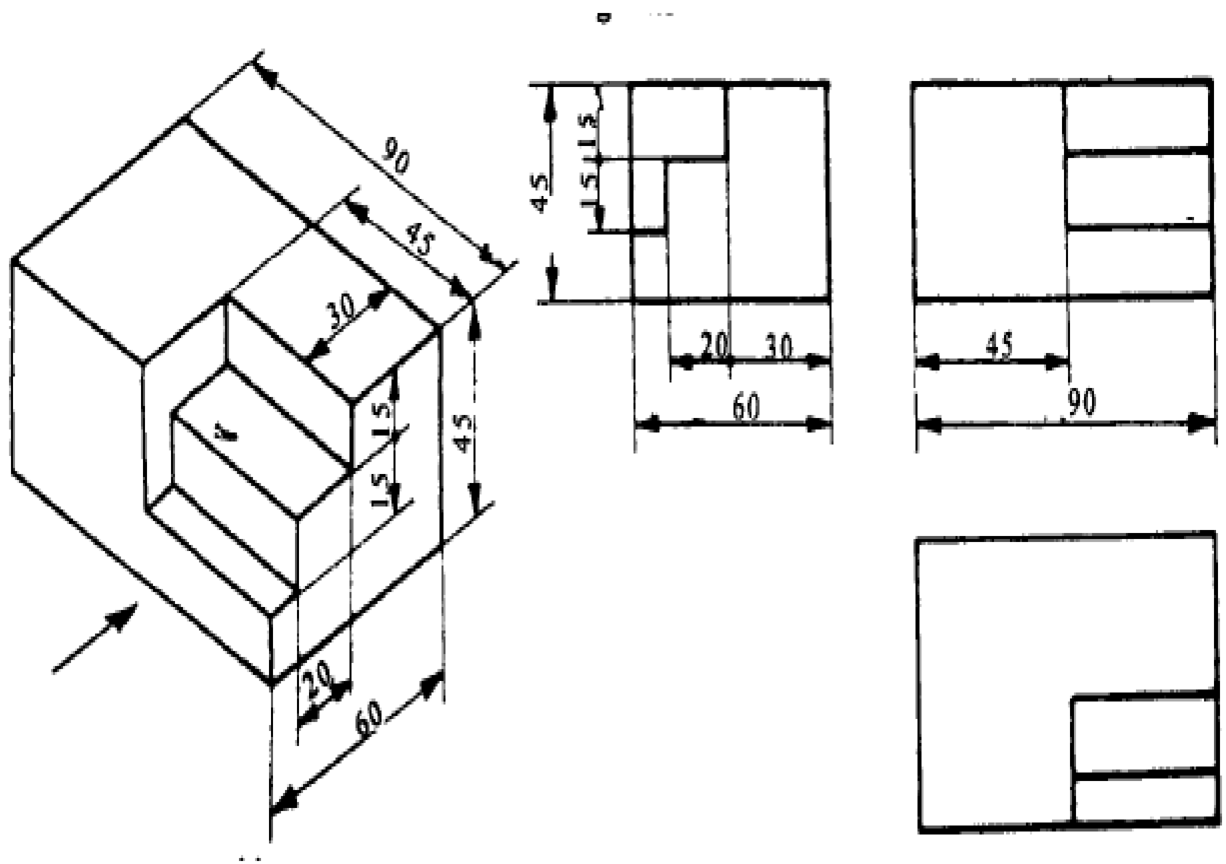


Fig : 11

Orthographic to Isometric

Sketch from multiview drawing

1. Interprete the ***meaning of lines/areas*** in multiview drawing.

2. Locate the lines or surfaces relative to isometric axis.

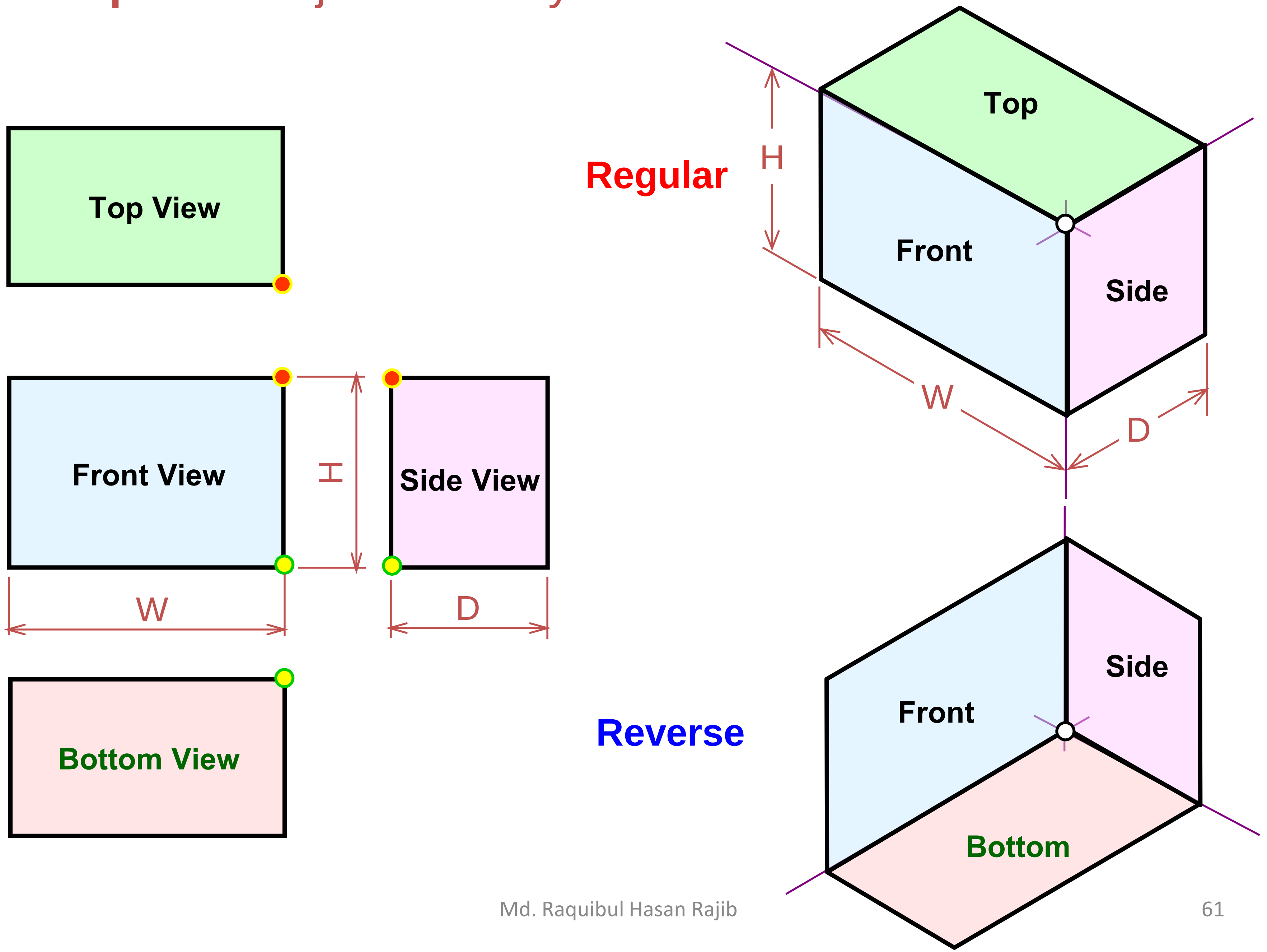
Orthographic to Isometric drawing :

The Boxing-in Method for Creating Isometric Drawings –

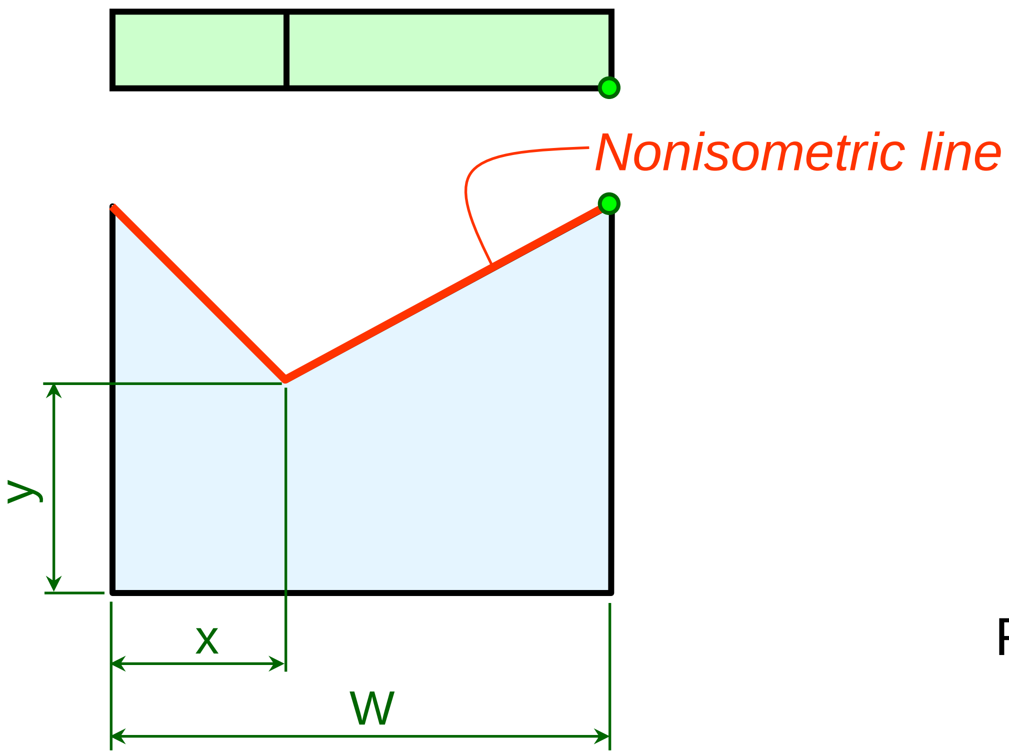
The four basic steps for creating an isometric drawing are:

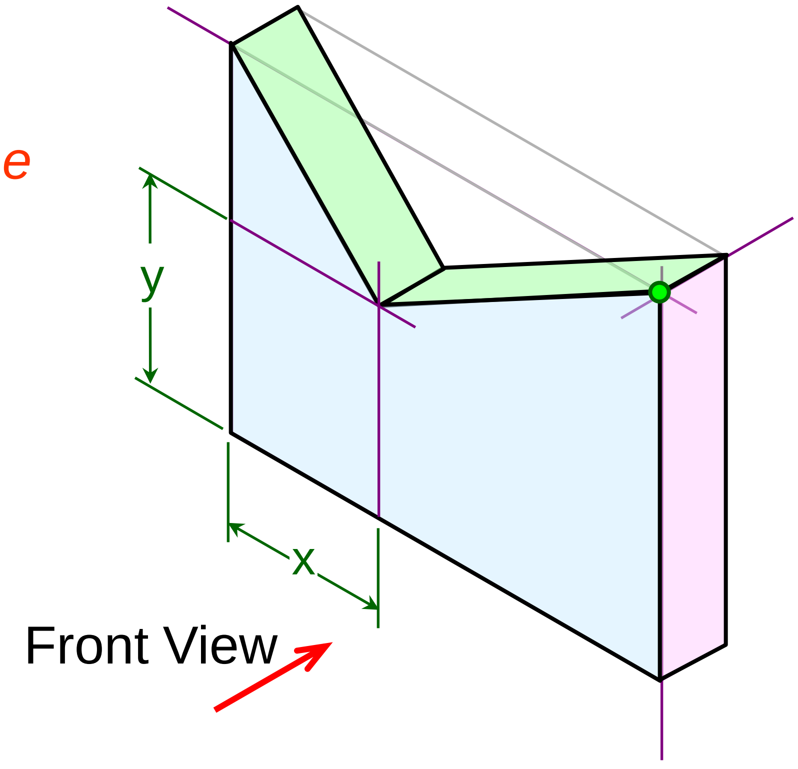
1. Determine the isometric viewpoint that clearly depicts the features of the object, then draw the isometric axes which will produce that view-point.
2. Construct isometric planes, using the overall width (W), height (H), and depth (D) of the object, such that the object will be totally enclosed in 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.

Example 1 : Object has only normal surfaces

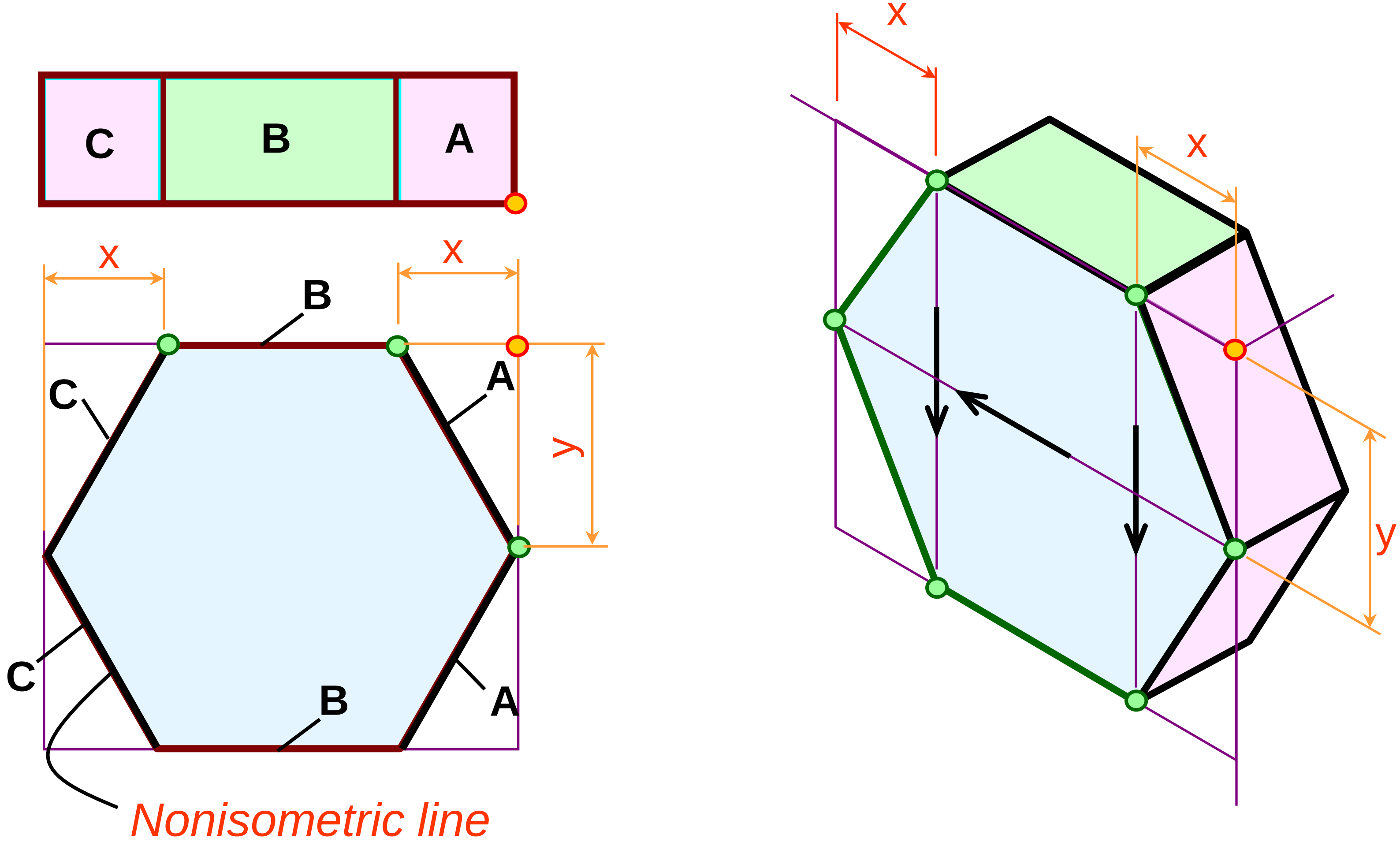


Example 2 : Object has inclined surfaces

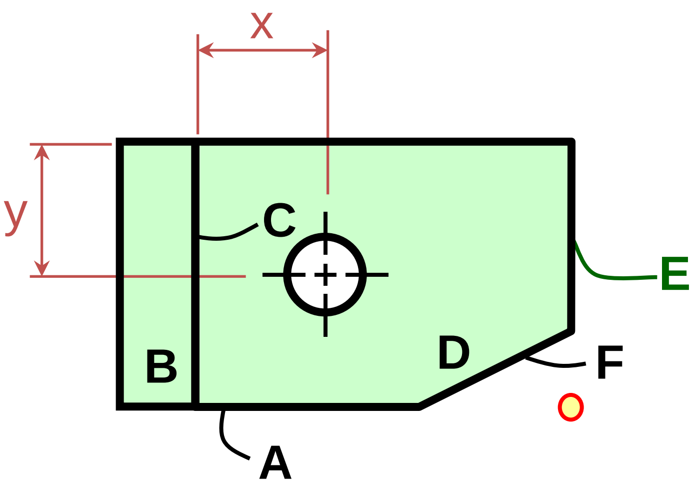


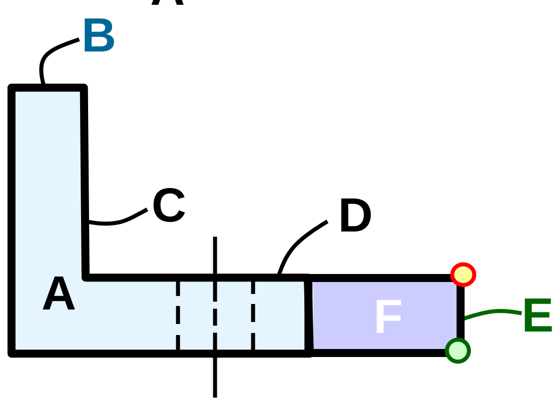


Example 3 : Object has inclined surfaces

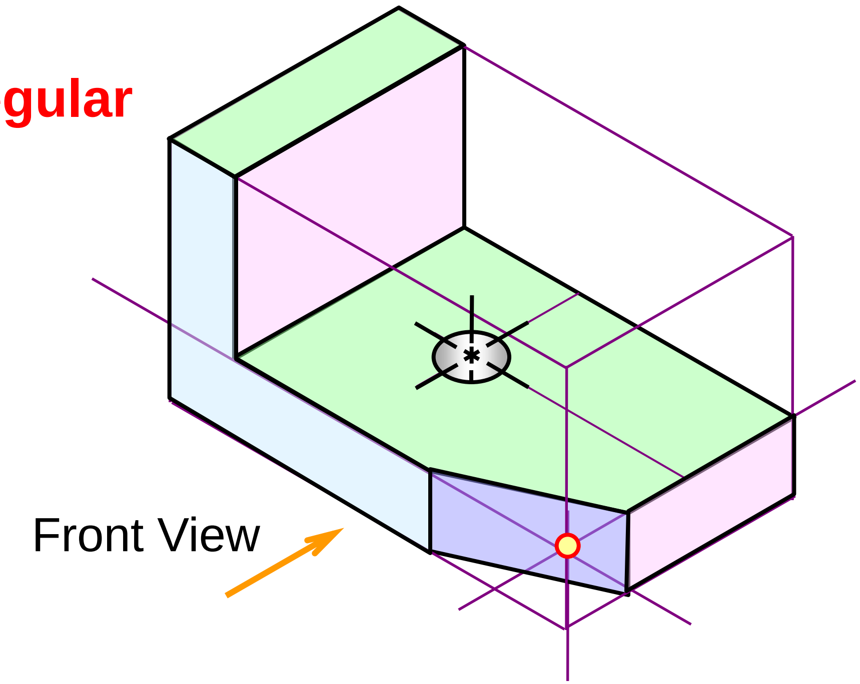


Example 4

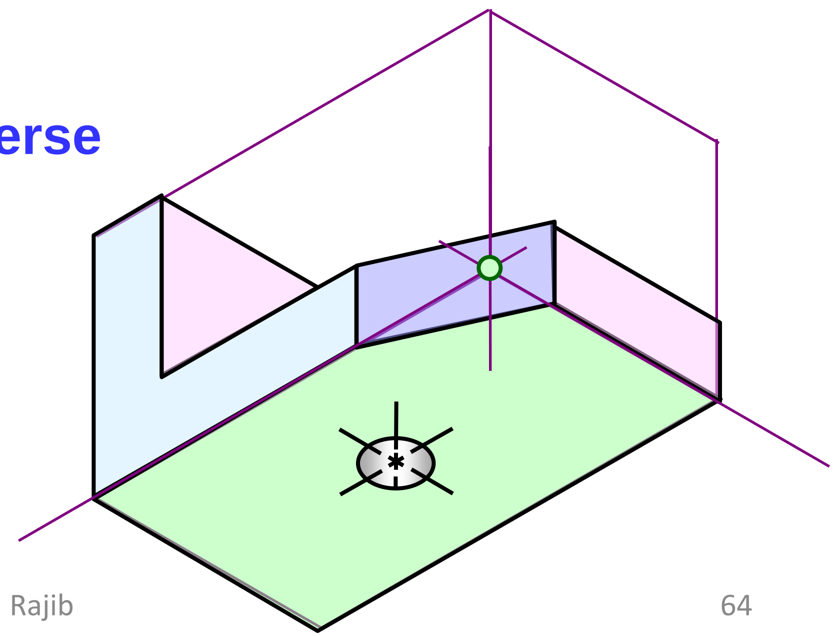




Regular

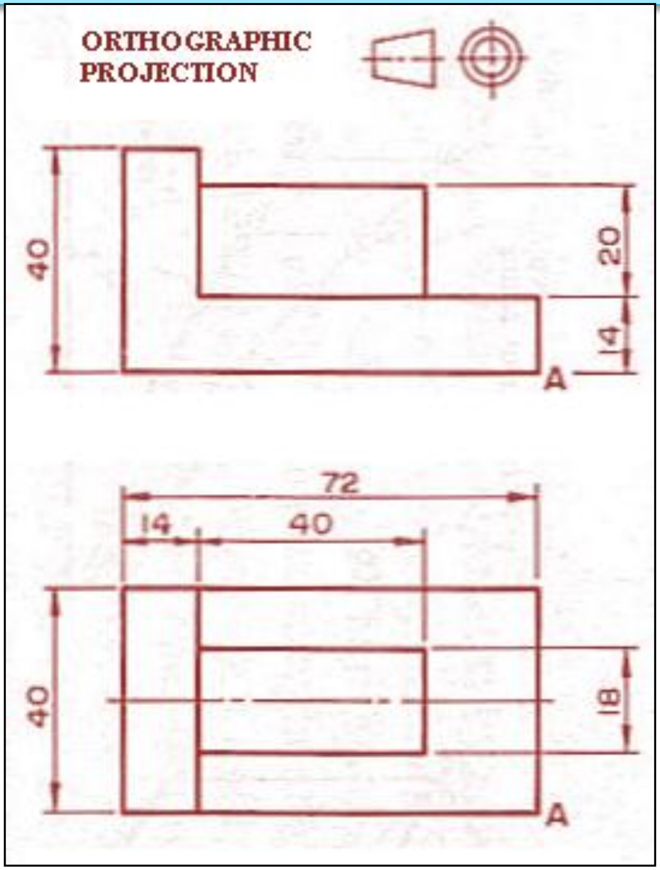


Reverse

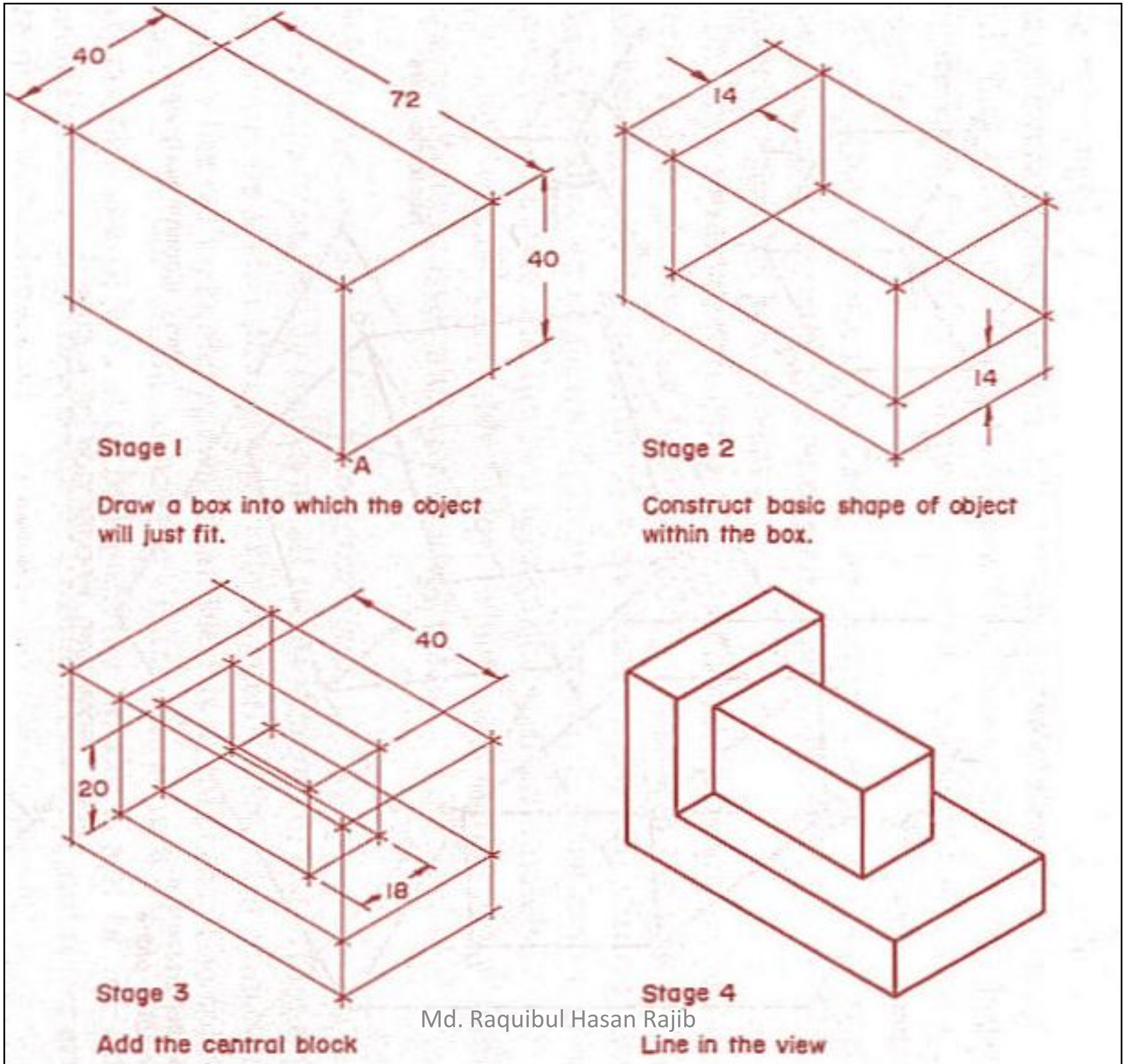


Objects with Normal Surfaces

Make an Isometric Drawing with corner A at the bottom

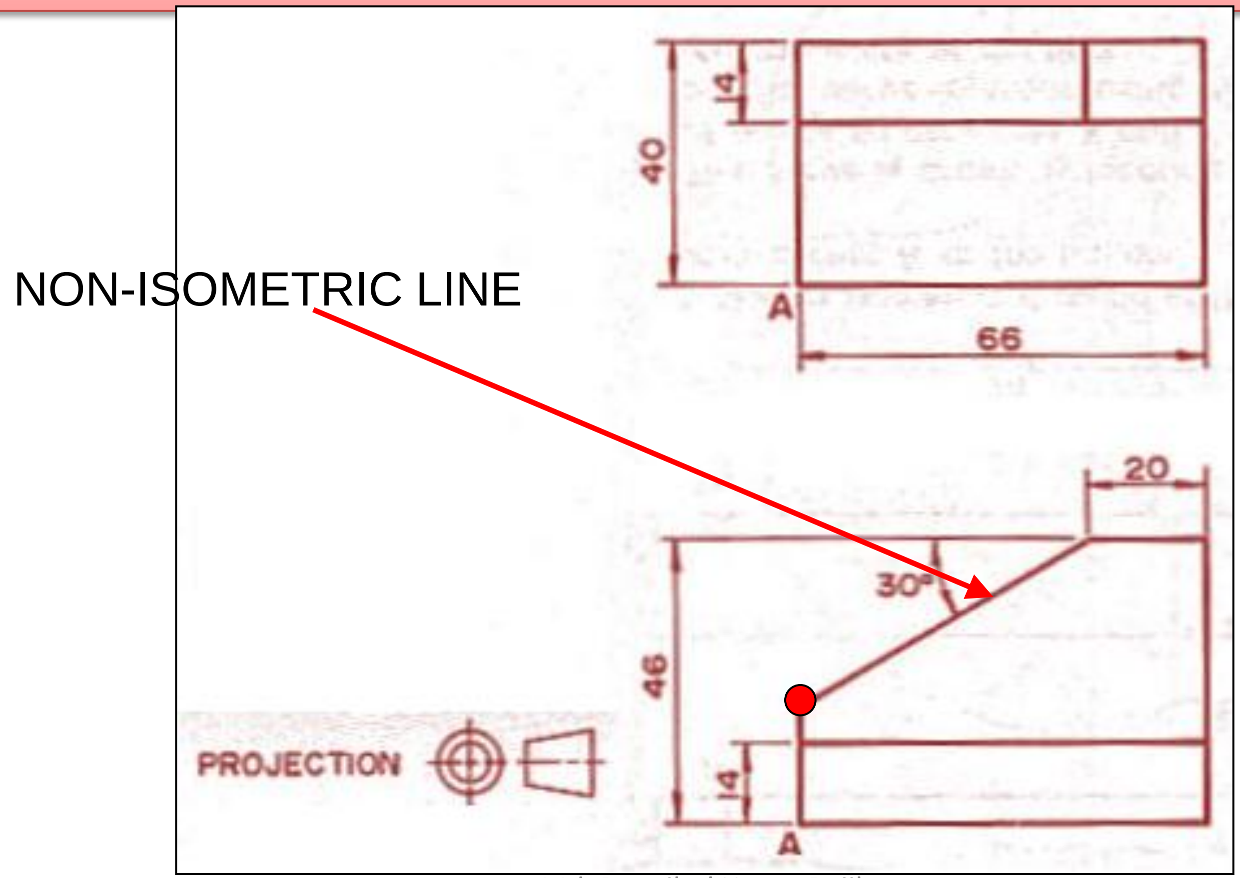


Objects with Normal Surfaces

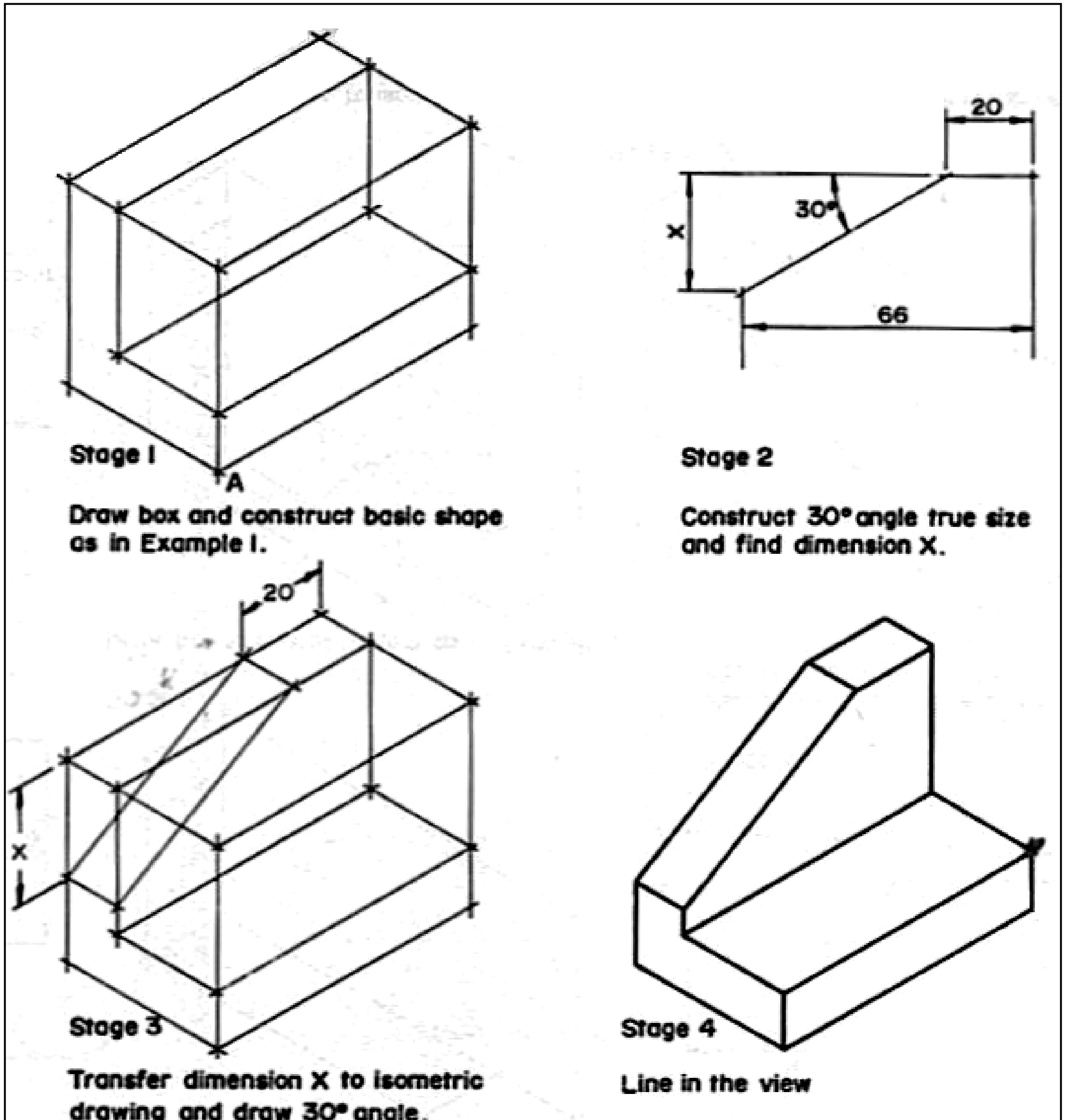


Objects with Oblique Surfaces

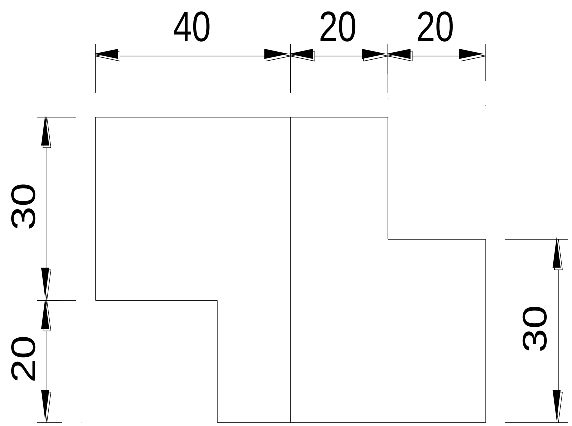
- Make an Isometric Drawing with corner A at the bottom



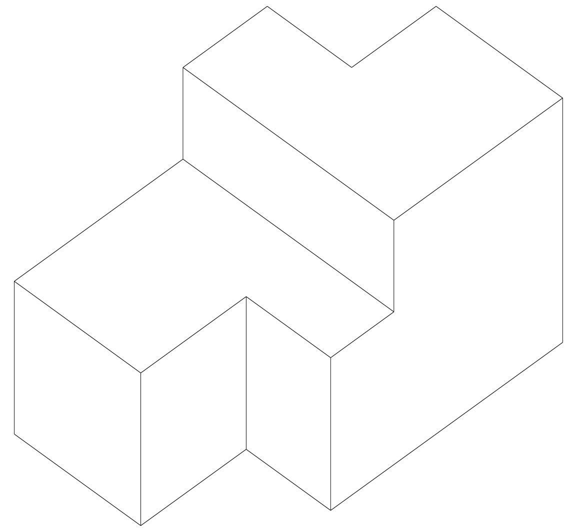
Objects with Oblique Surfaces

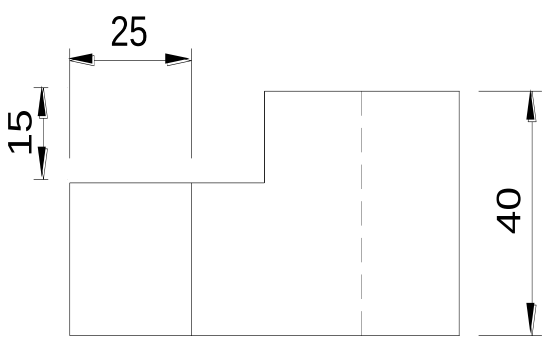


Draw isometric view from the given orthographic projections

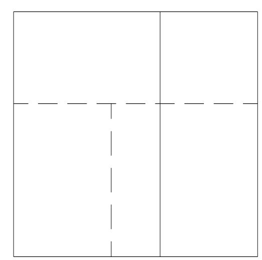


Plan

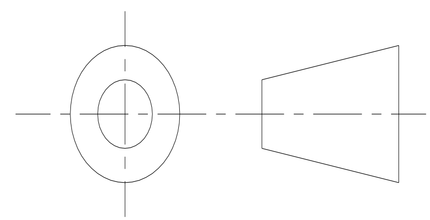


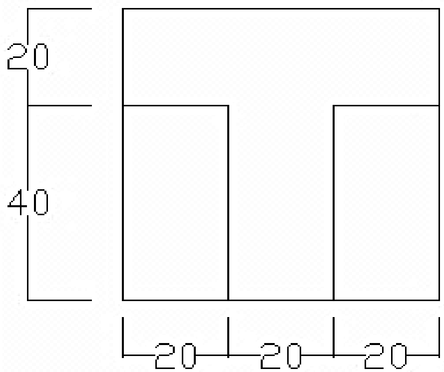


Elevation

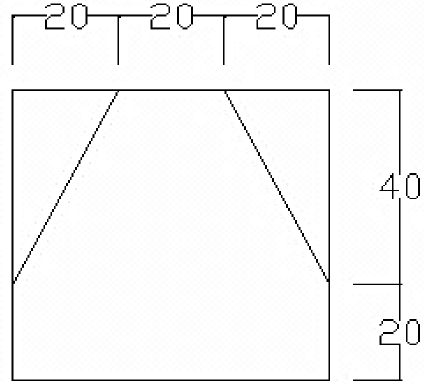


End Elevation

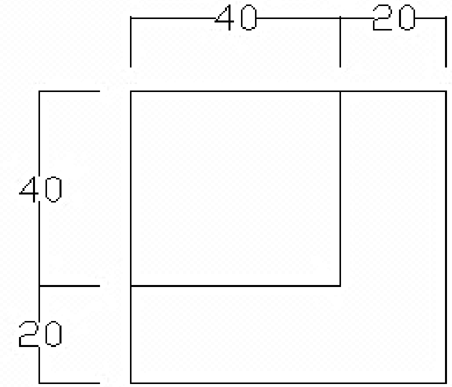




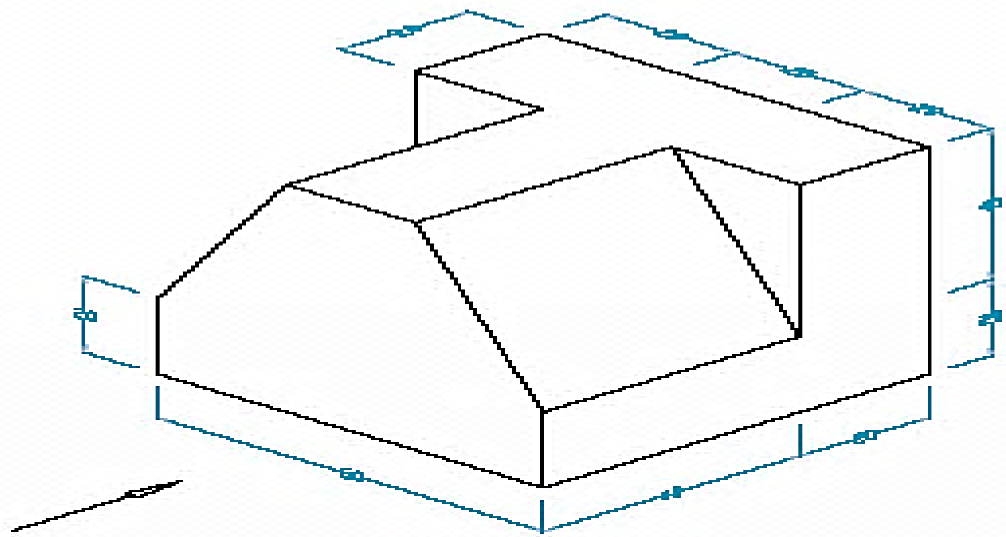
TOP VIEW



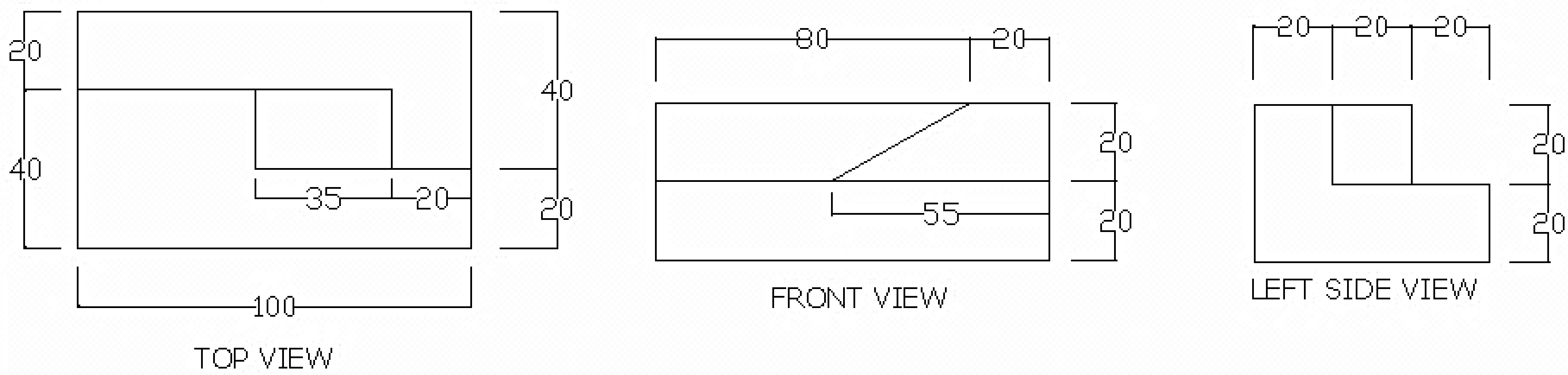
FRONT VIEW

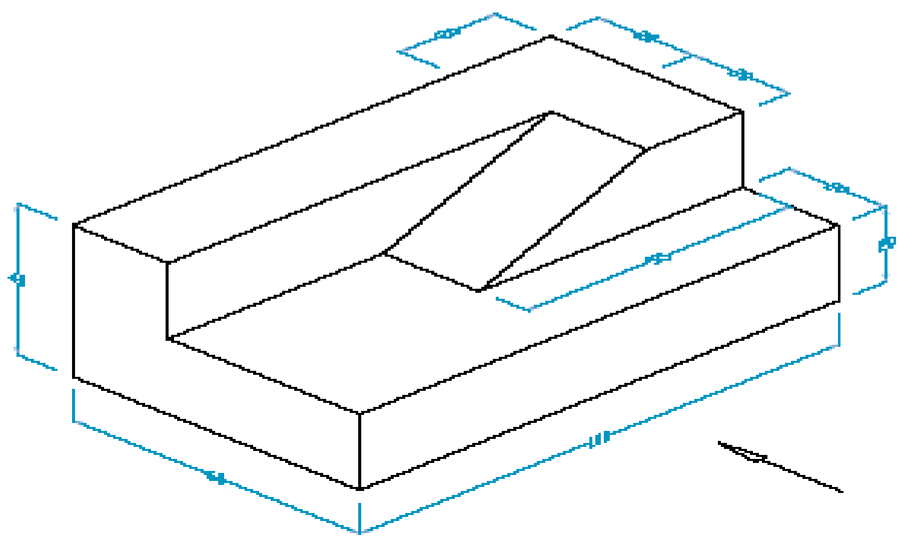


RIGHT SIDE VIEW

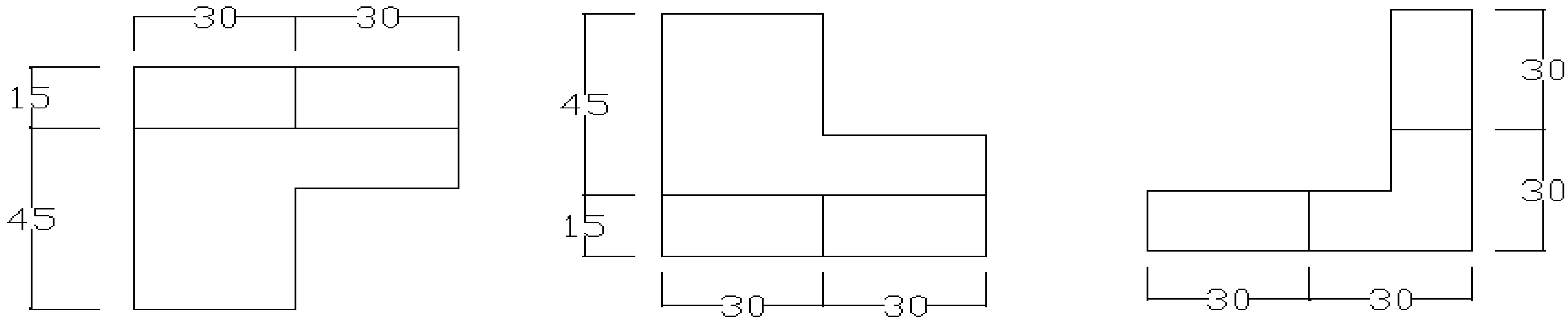


Isometric Projection

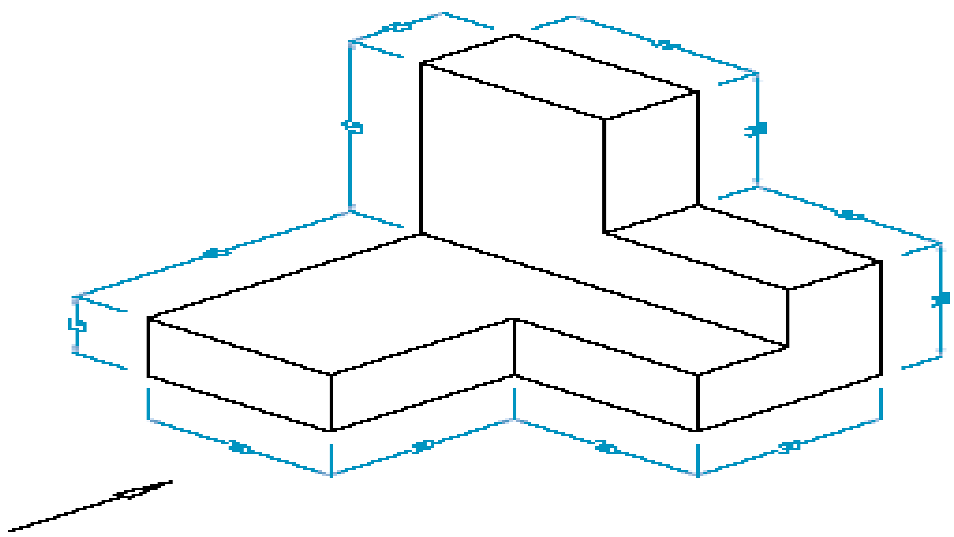




Isometric Projection

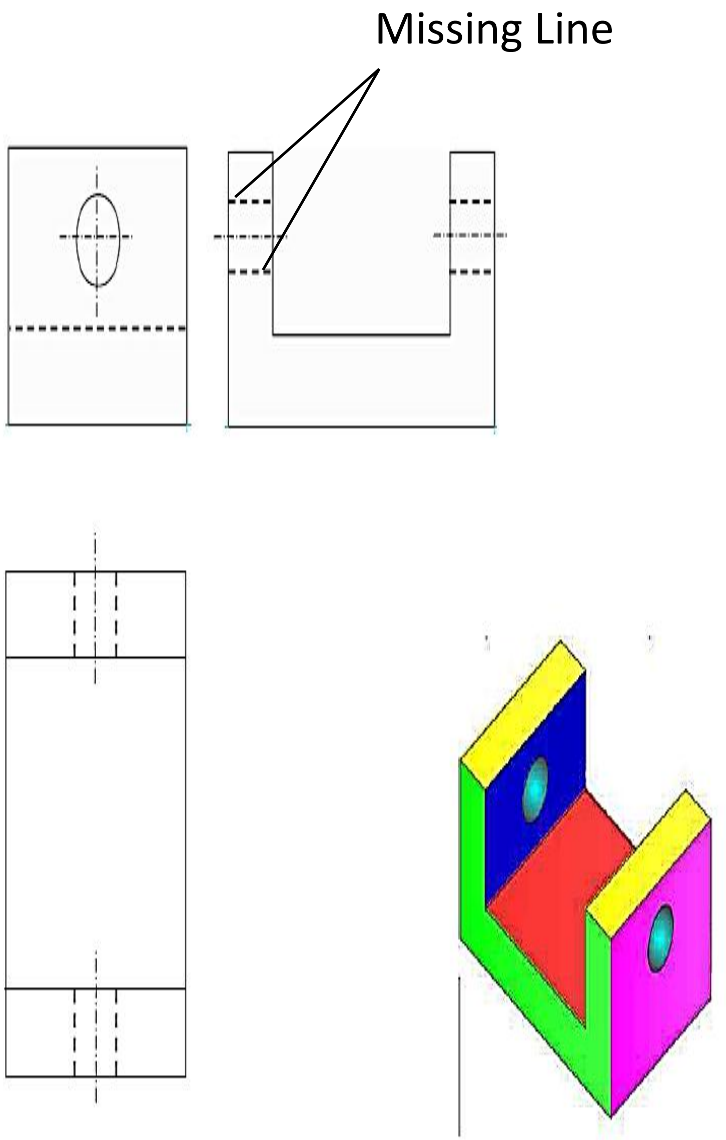


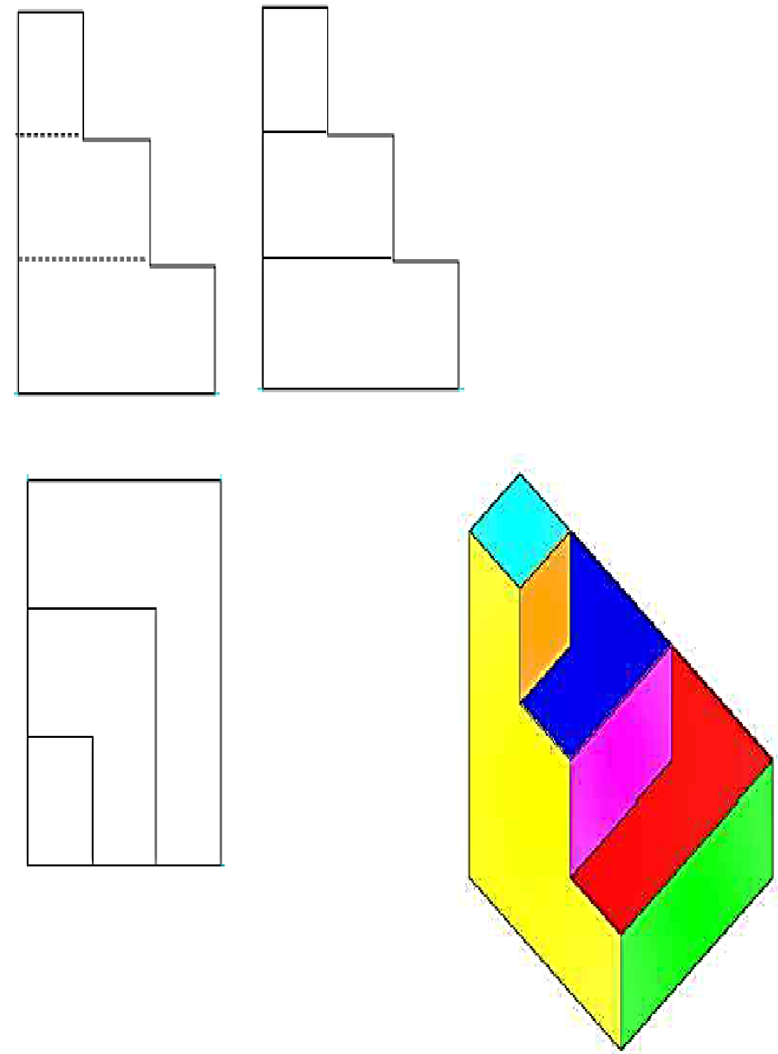
TOP VIEW FRONT VIEW RIGHT SIDE VIEW



Isometric Projection

Missing Line


Missing Line



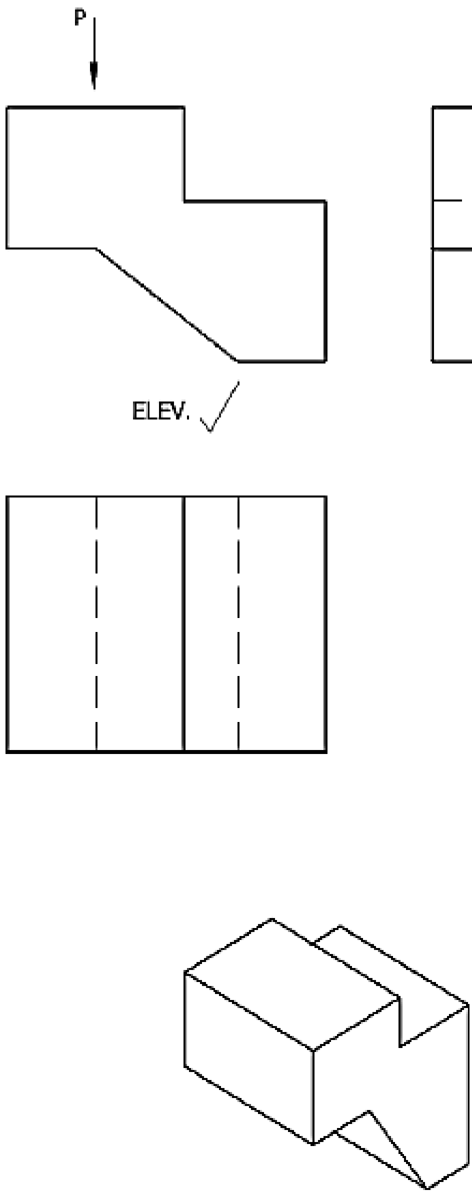
Missing View :

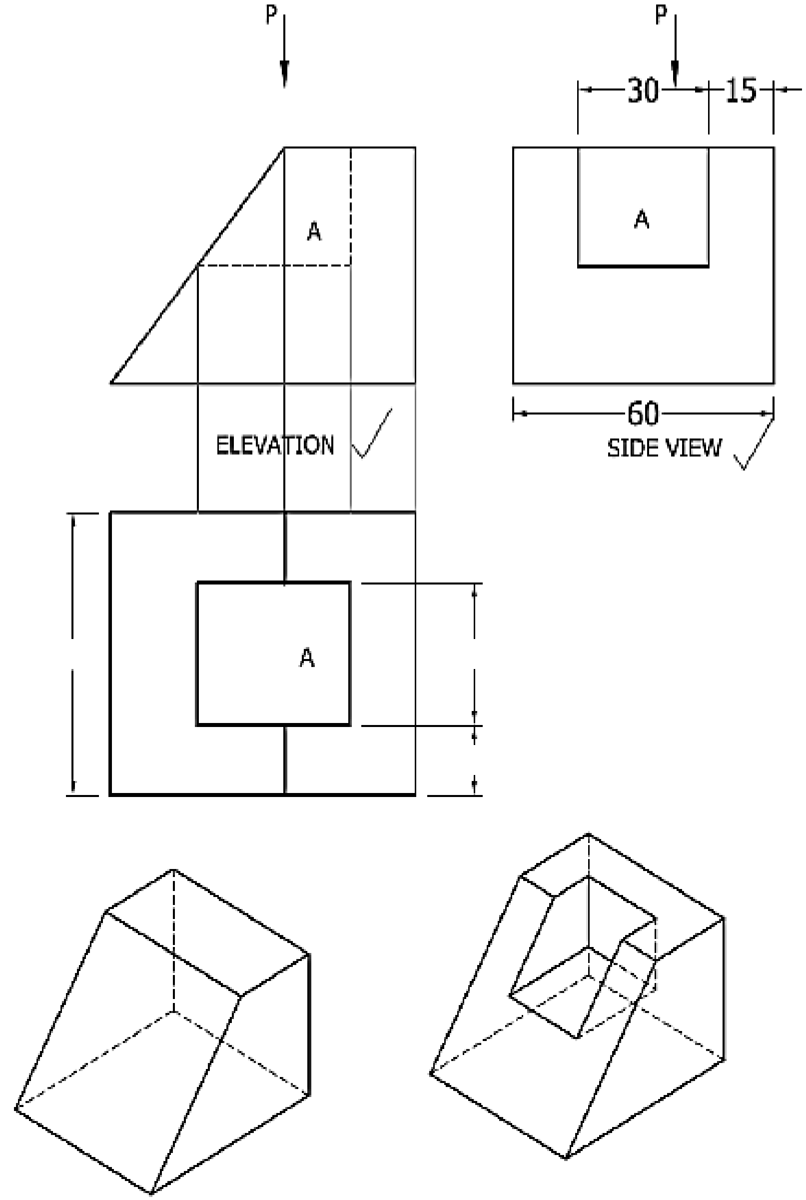
Two views are sufficient to give full description of the 3-D objects. Usually, two views are given, either (Elevation and Side View) or (Elevation and Plan), and it is required to draw the third view.

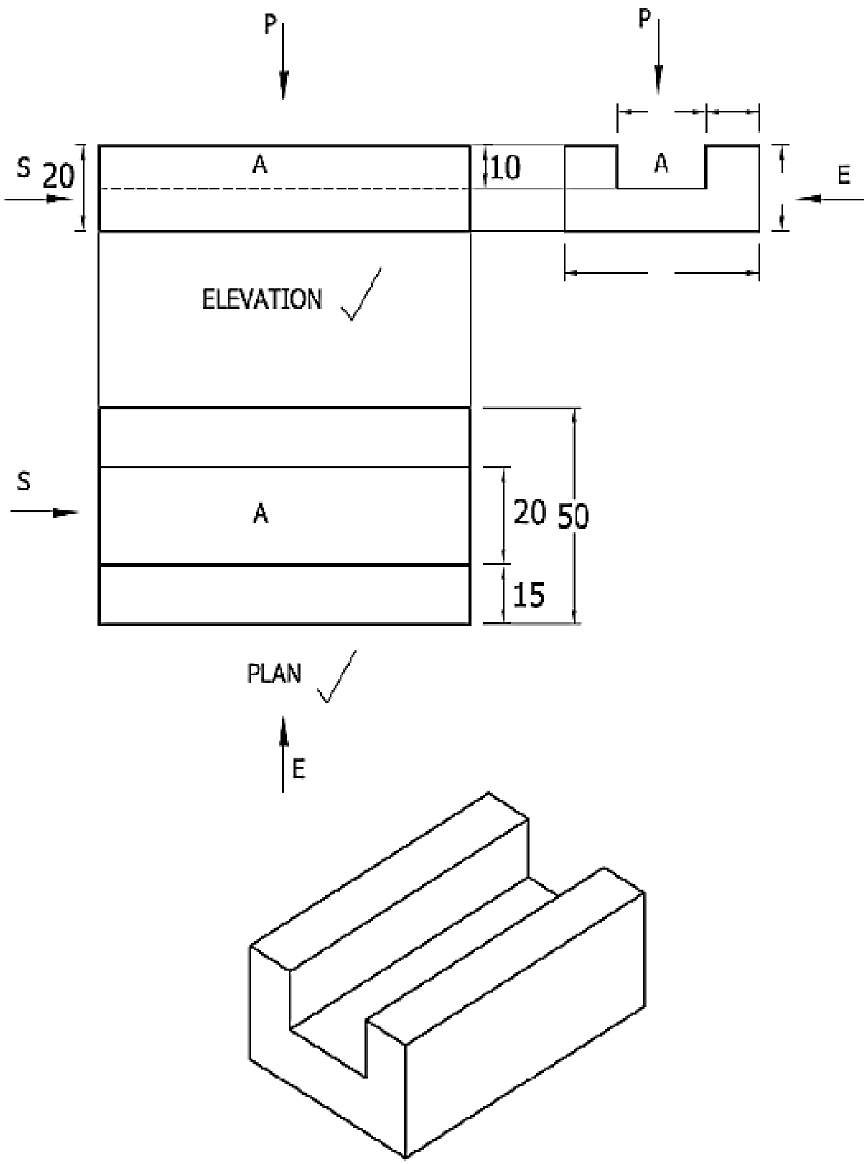
Reading the drawing is necessary to interpret the actual pictorial shape of the actual object from the given two views. The following outlines simplify the method by which you can get a good imagination of the nonexistent 3-D.

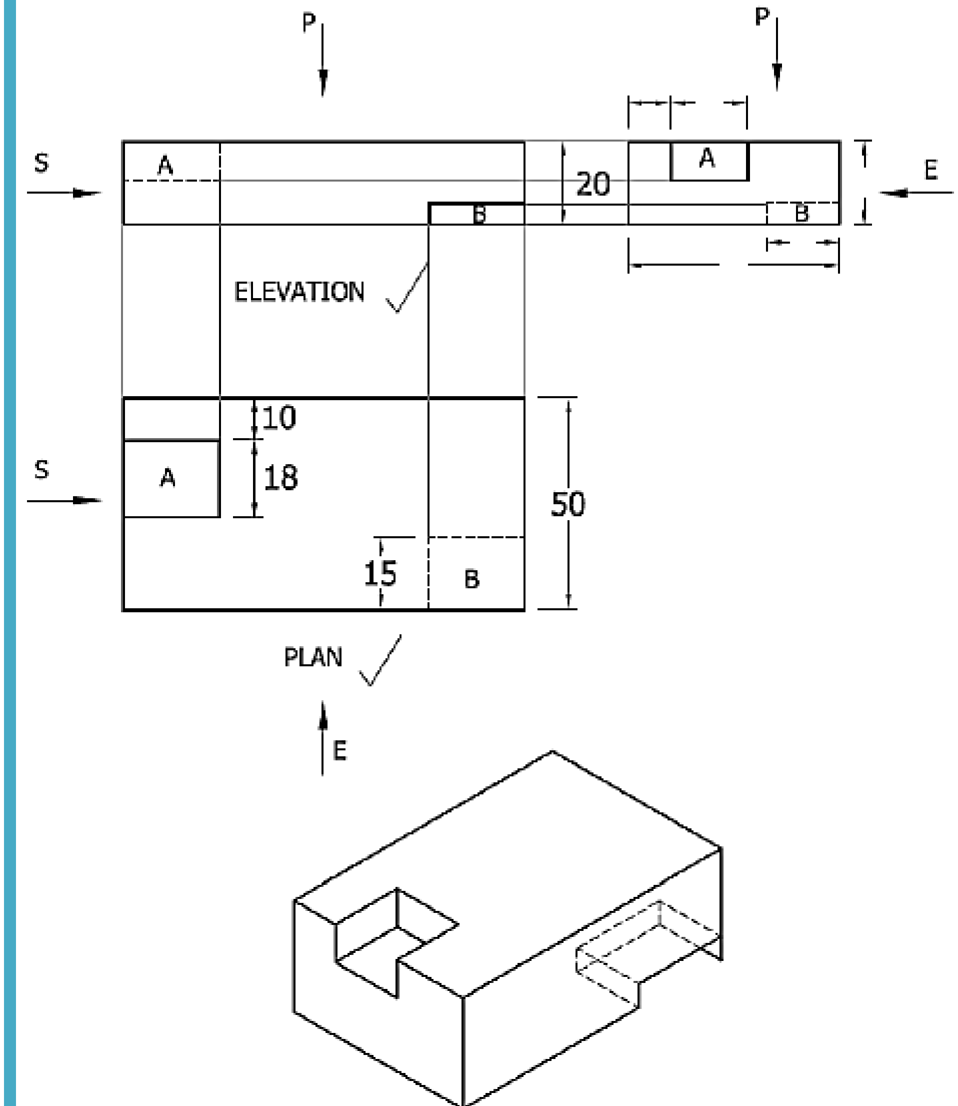
Also, by which we will interpret the missed (or third) view.

1. Scan all points, lines and surfaces of the objects.
2. Define the general idea of the over-all shape of the 3-D object. Try to refer the object to a group of points, lines, planes, cubes, cylinders, cones, pyramids. Also the object may be decomposed into base like Box, basic parts and connectors like webs. Basic parts can be divided into basic elements.
3. Project every part individually and remember to correct the joints between them to form the entire 3-D object. Re-project any detail or connection that was not clear at your first trial of scanning or imagination of the object.


P
P
ELEV.
S.V.


P
P
30
15
A
A
60
ELEVATION
SIDE VIEW
A


P
P
S
20
A
10
A
E
ELEVATION
S
A
20
50
15
PLAN
E


P
P
S
A
20
A
B
B
E
ELEVATION
10
S
A
18
50
15
B
PLAN
E

Sectional View

Rules to Remember When Sectioning

- A sectional view shows the part of the component in front of the cutting plane arrows. In third-angle projection the sectional view is placed on the side behind the sectioning viewing plane.

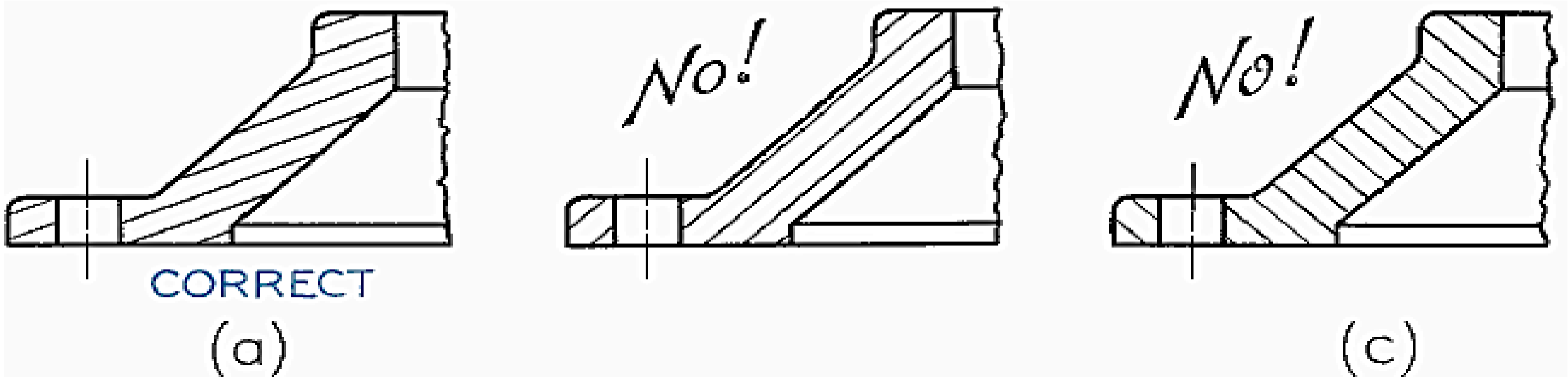
- Material which has been cut by the cutting plane is hatched. Standard exceptions are noted previously.

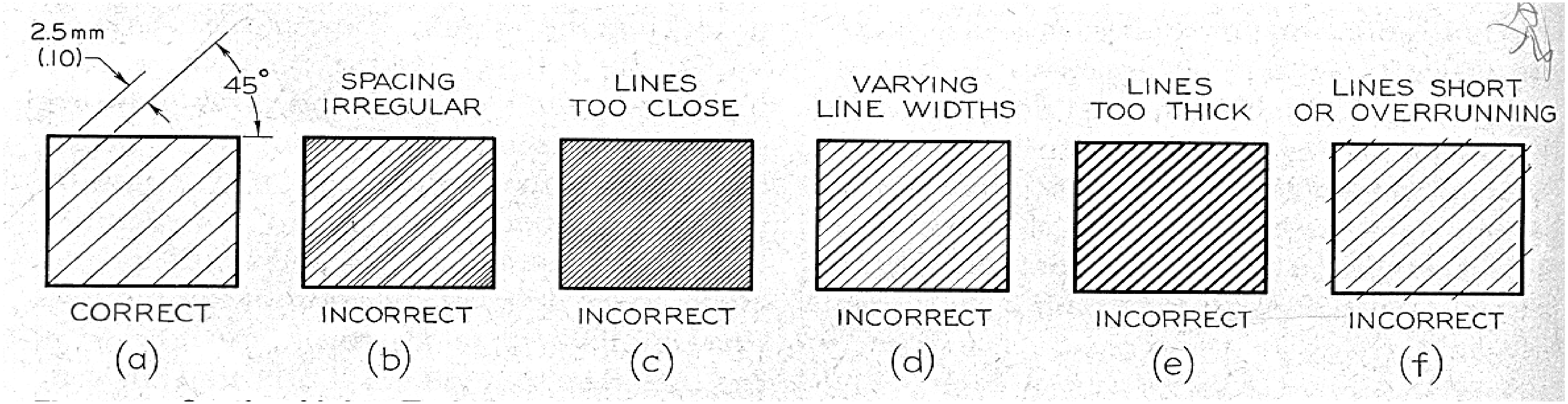
- A sectional view must not have any full lines drawn over hatched areas.

- As a general rule, dimensions are NOT inserted in hatched areas.

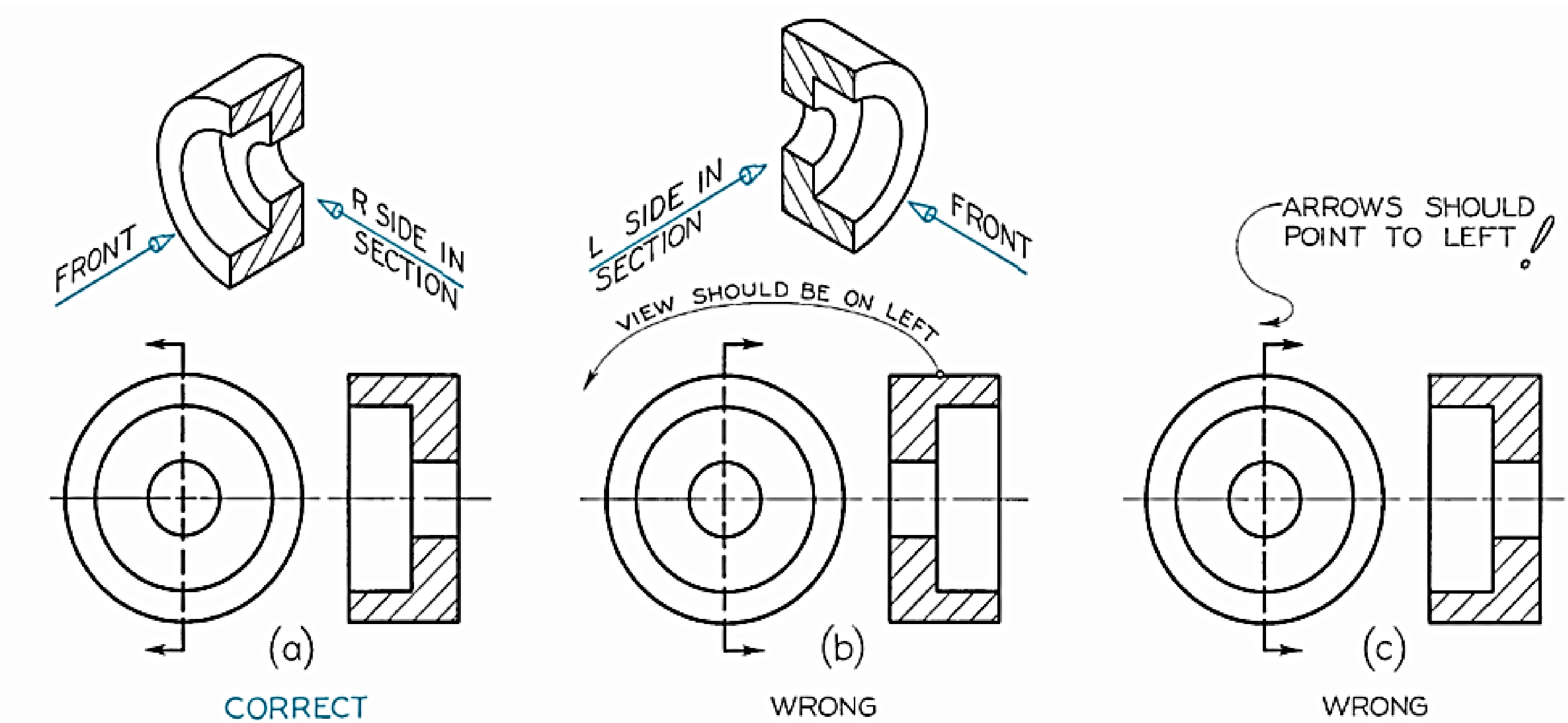
Section-lining rules

If section lines drawn at 45º with horizontal would be parallel or perpendicular (or nearly so) to a prominent visible outline, the angle should be changed to 39º or some odd angle.





Correct and incorrect placements of sectional views and sectioning line:



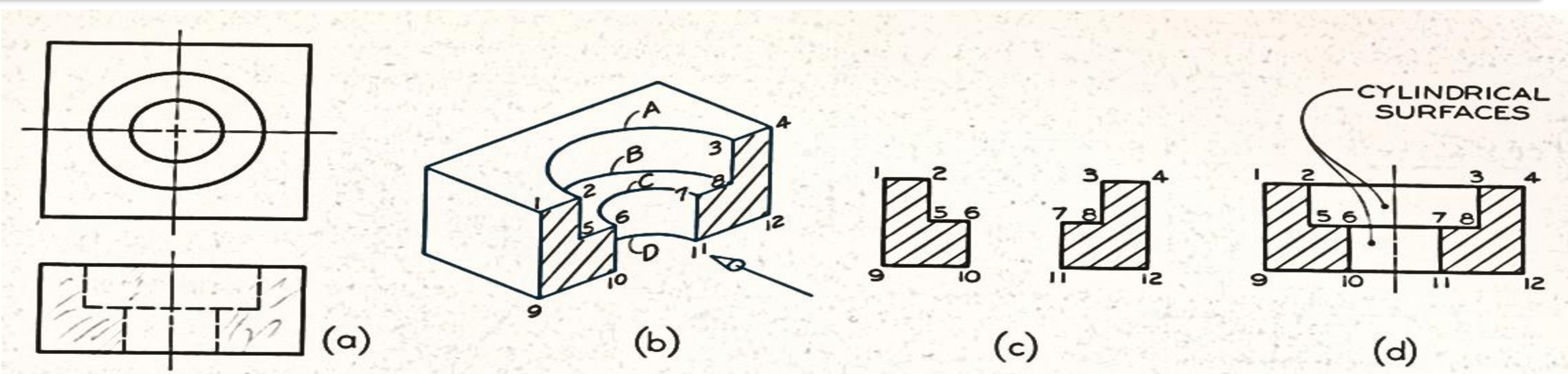
Visualizing a Section:

1. An object with a drilled and counter bored hole is to be sectioned. The cutting plane is assumed along the horizontal centerline in the top view, and the front half of the object is imagined to be removed.

2. The two cut surfaces produced by the cutting planes are 1-2-5-6-10-9 and 3-4-12-11-7-8. The section at (c) us incomplete because certain visible lines are missing.

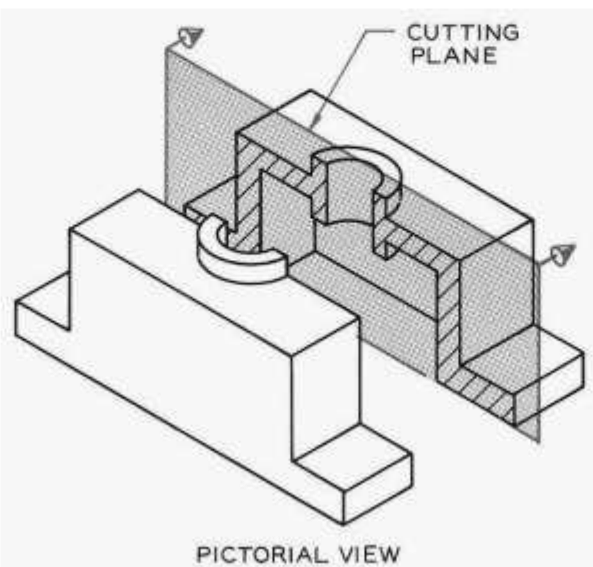
3. If the section is viewed in the direction of sight as shown at (b), arcs A, B, C, and D will be visible. As shown at (d) these arcs will appear as straight lines 2-3, 6-7, 5-8, and10-11.

4. The top and bottom surfaces of the object appear in the section as lines 1-4 and 9-12. The bottom surface of the counter bore appears as line 5-8.

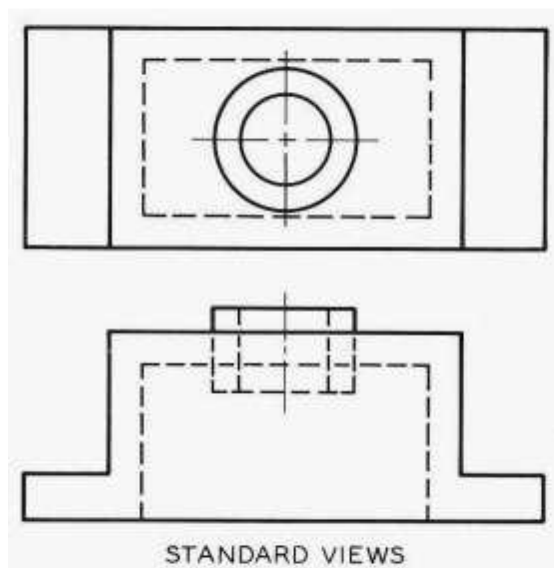


Sectional view :

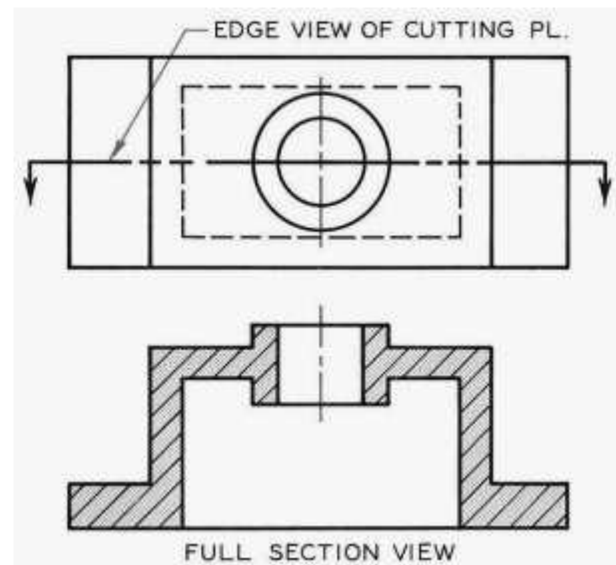
- A section is an imaginary cut taken through an object to reveal the shape or interior construction. **Fig. 2a** shows the **imaginary cutting plane** in perspective view.
- The imaginary cutting plane is projected on a standard view so that the **sectional view** with orthographic representation is obtained as shown in **Fig. 2c**.
- A sectional view must show which portions of the object are solid material and which are spaces. This is done by **section lining (cross-hatching)** the solid parts with uniformly spaced thin lines generally at 45º.



(a)

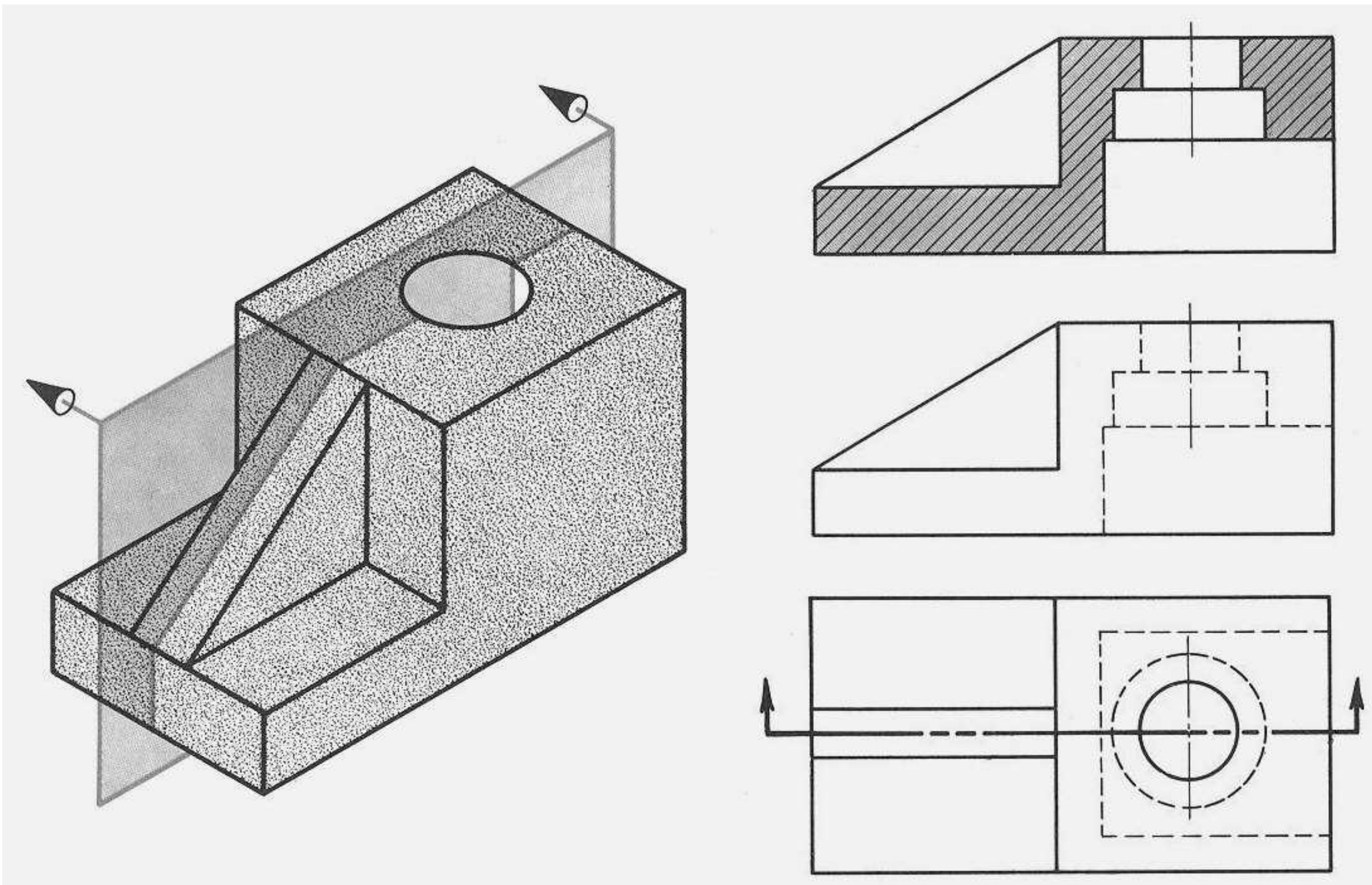


(b)

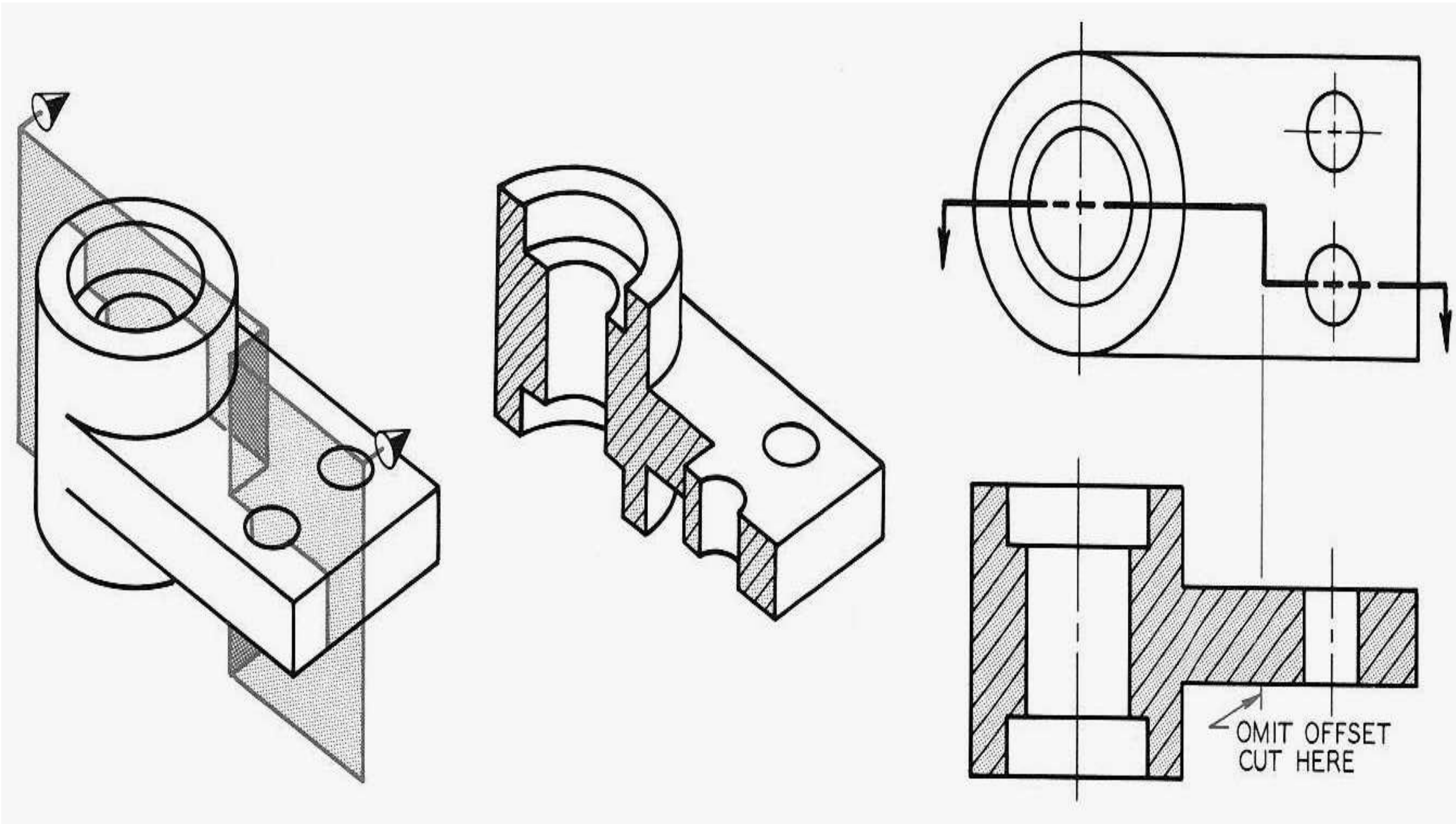


(c)

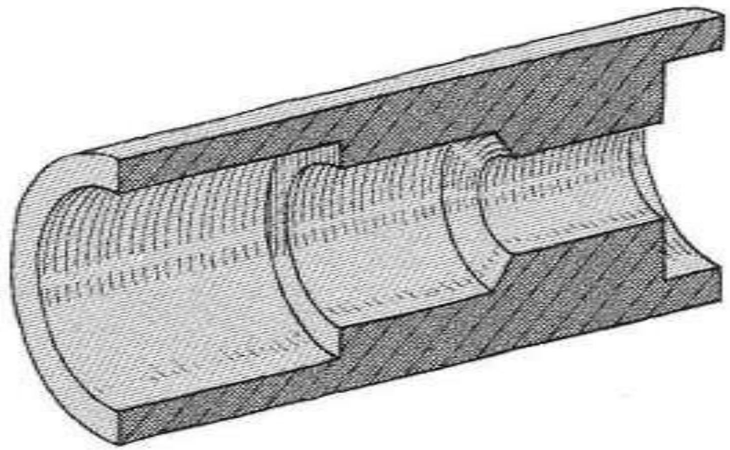
Examples:

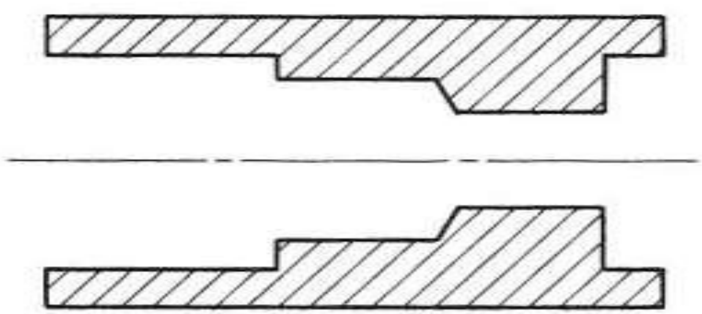


Examples:

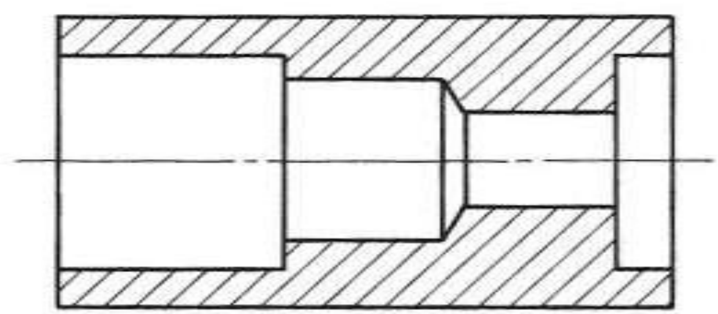


Examples:





(a)



(b)

Auxiliary View

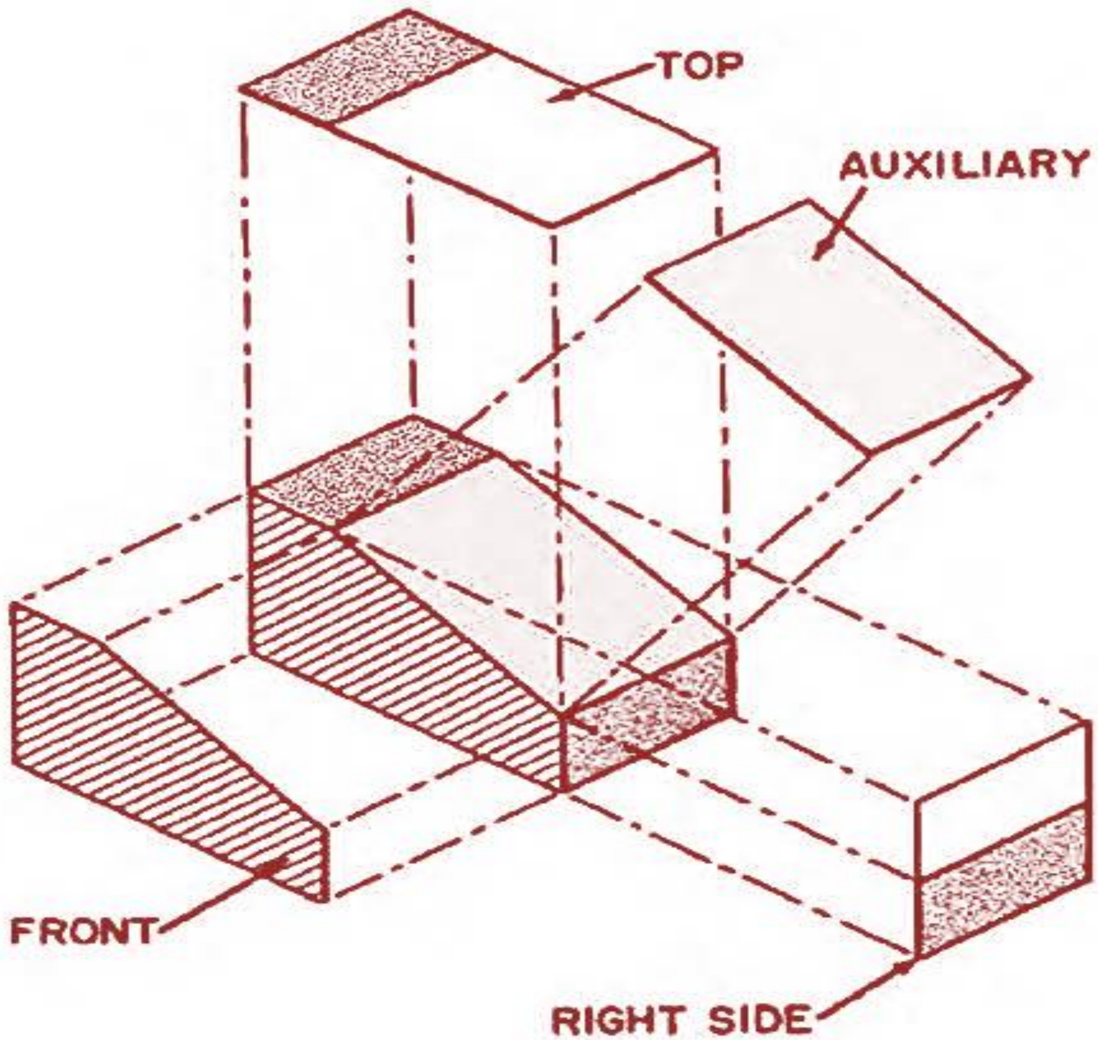
<u>*Introduction:*</u>

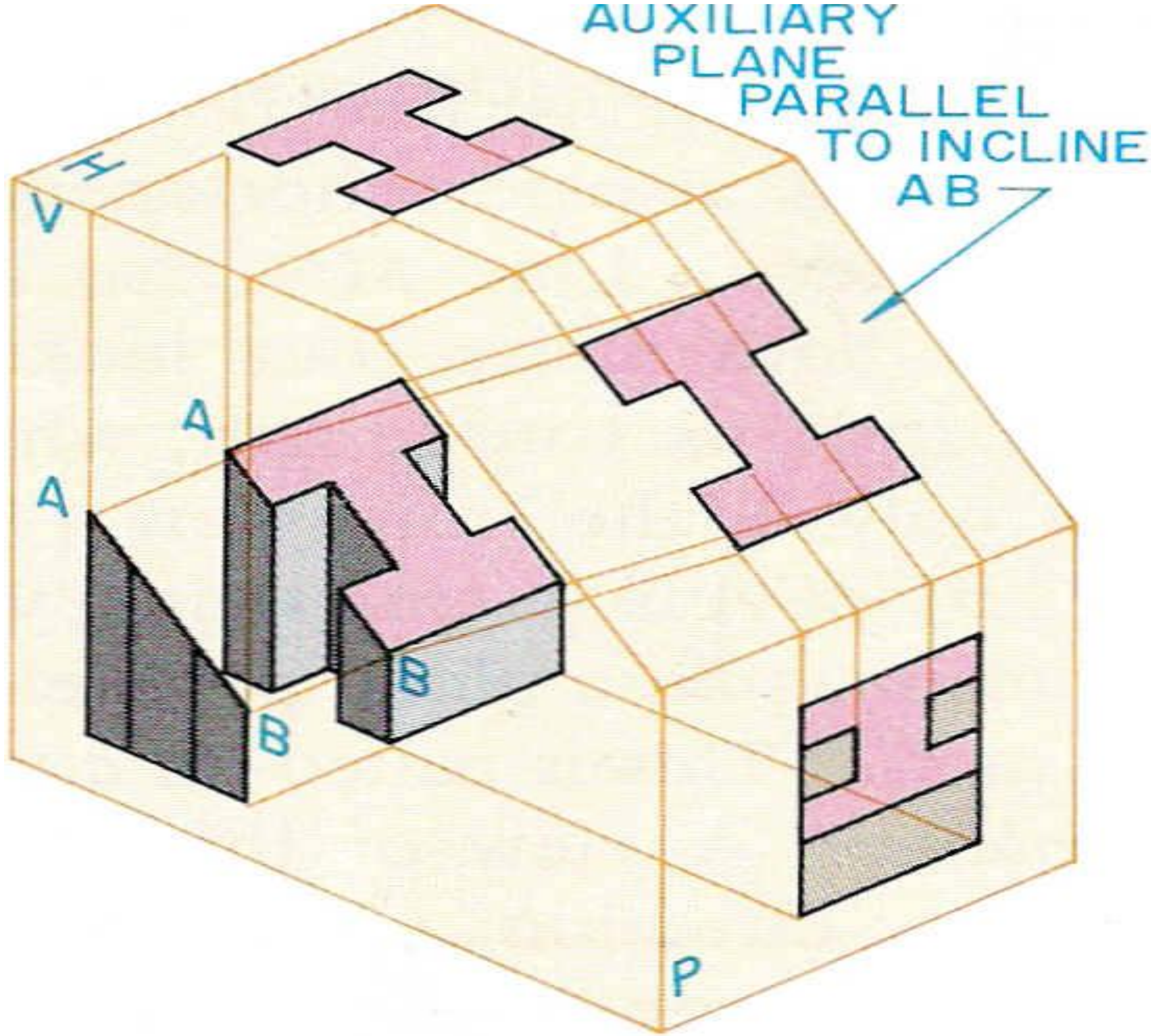
- With "***Multi view or Three View Projections***," it is easy to describe an object with views on the three regular planes of projection. These are the ***top***, or horizontal plane; the ***front***, or vertical plane; and the ***side***, or profile plane. With these planes, many graphic problems can be solved.

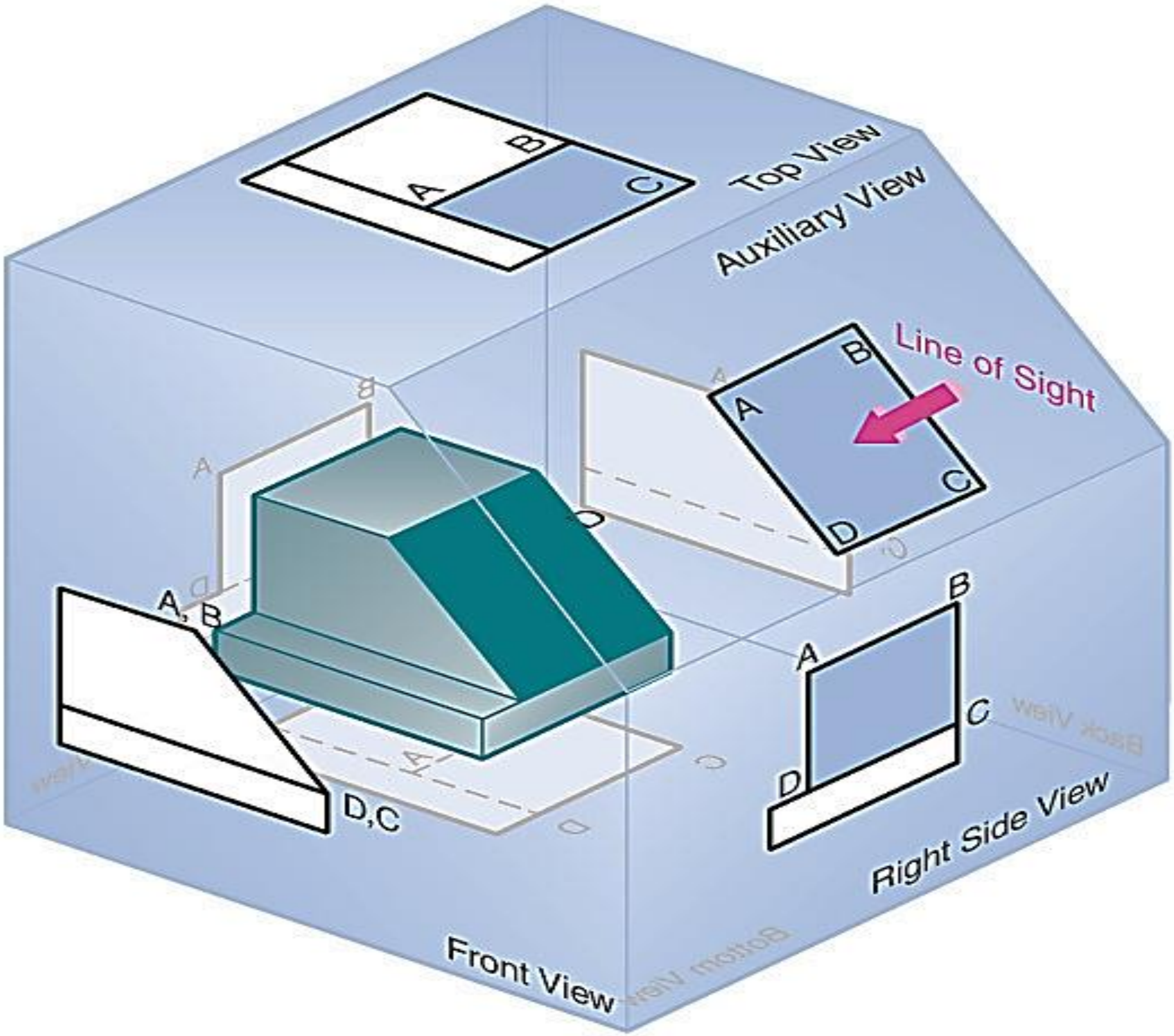
- However, to solve problems involving inclined (slanted) surfaces, need to learn to draw views on auxiliary (additional) planes of projection. These are called <u>***auxiliary views***</u>.

- When an object has inclined surfaces, these do not show up in true shape or size in regular views. However, a view on a plane parallel to the inclined surface does show its true size and shape. This is an ***auxiliary view***. It, along with the other regular views describe the object better.

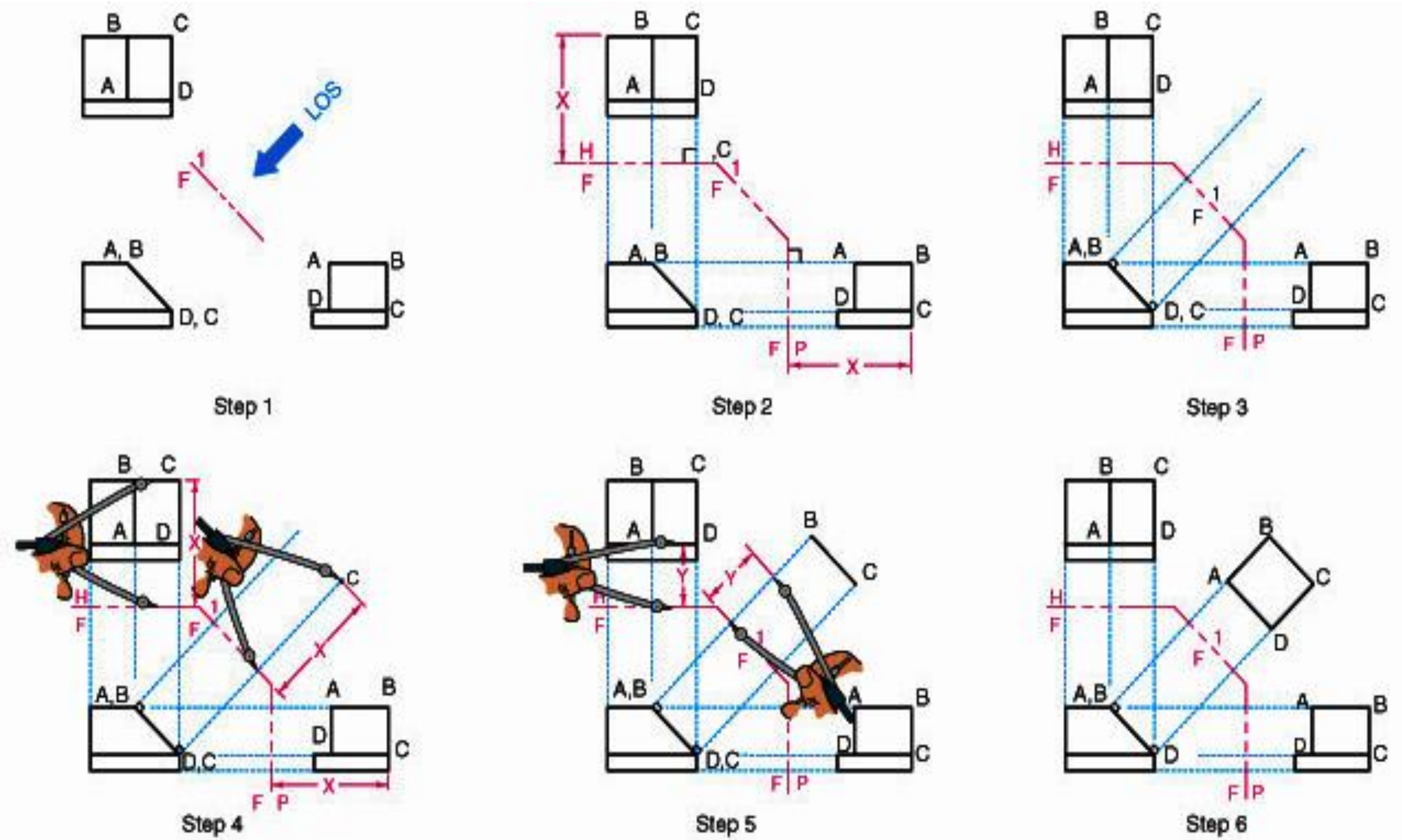
Figure of an Auxiliary View:



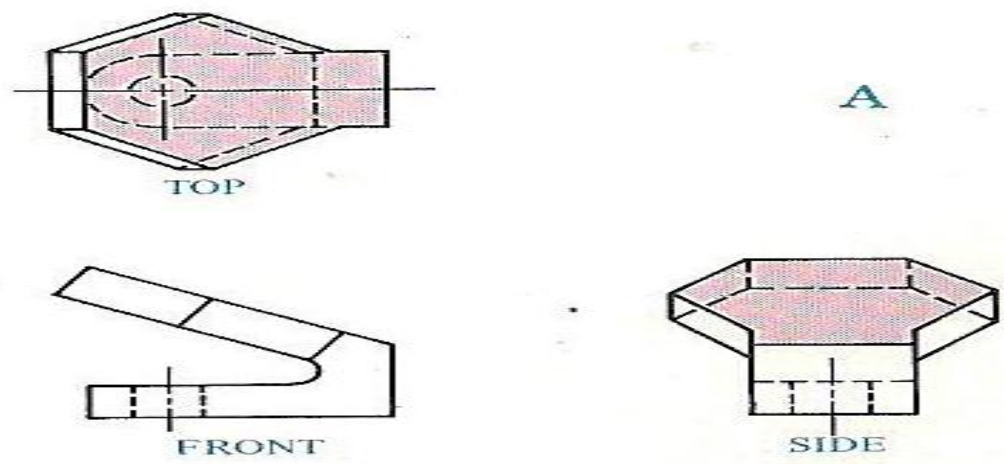

AUXILIARY
PLANE
PARALLEL
TO INCLINE
AB
H
V
A
A
B
B
P


Top View
A
B
C
Auxiliary View
Line of Sight
A
B
C
D
A, B
D,C
A
B
C
D
Right Side View
Front View

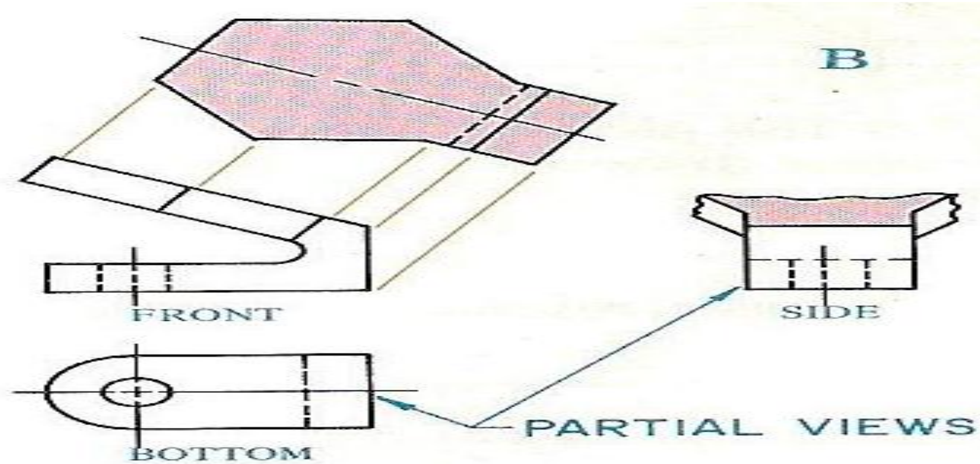
Technique to draw a depth auxiliary

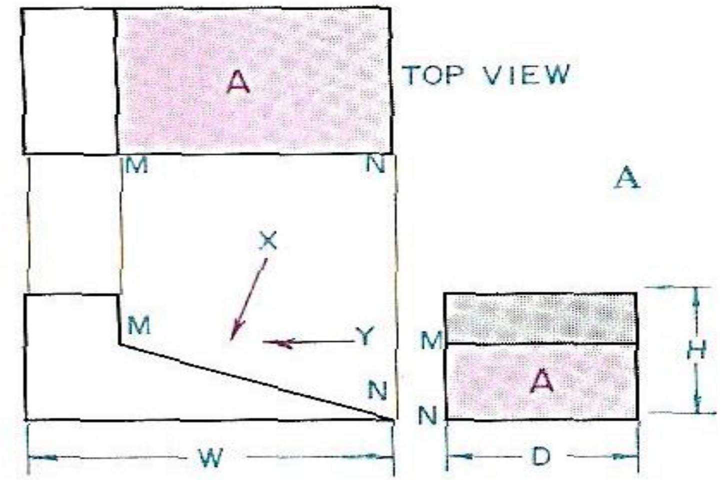


Regular Views



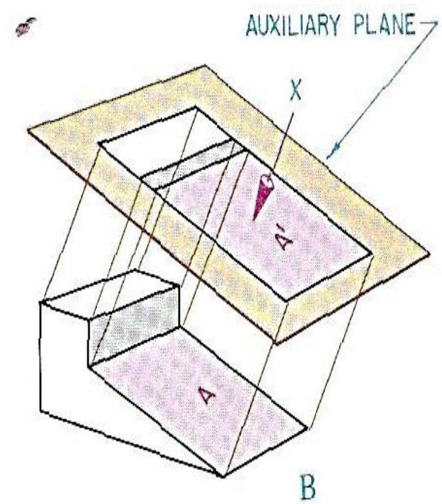
Regular Views with
Auxiliary View

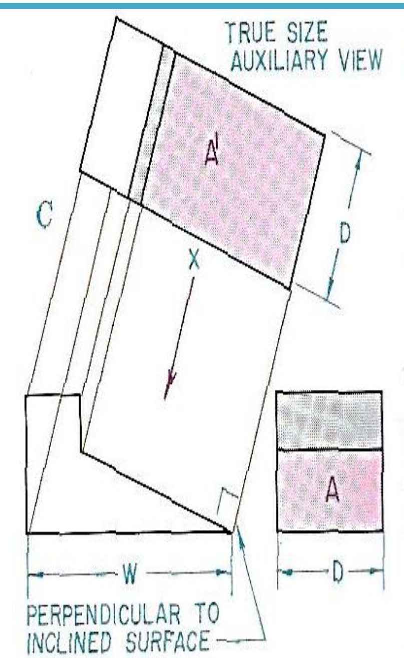




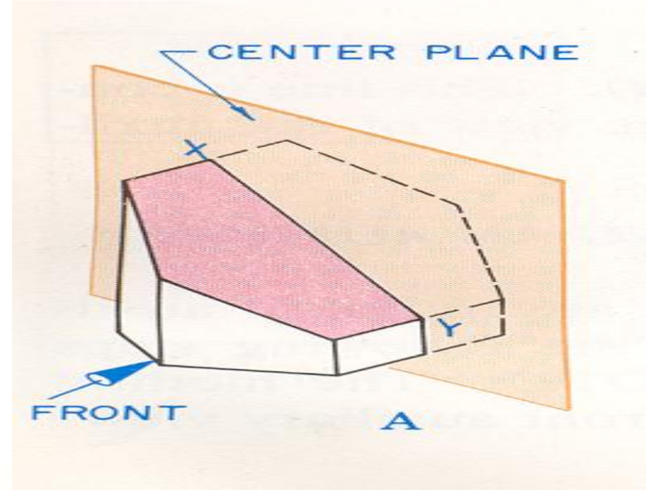
In the figure to the left, a simple inclined wedge block is shown in the regular views. In none of these views does the slanted surface, called "***A***", appear in its true shape. In the front view, all that shows is its edge line ***MN***. In the side view, which is made by looking in the direction of arrow ***Y***, surface ***A*** appears, but it is fore-shortened. **Surface *A*** is also fore-shortened in the top view. Line ***MN*** also appears in both views, but looking shorter than its true length, which shows only in the front view.

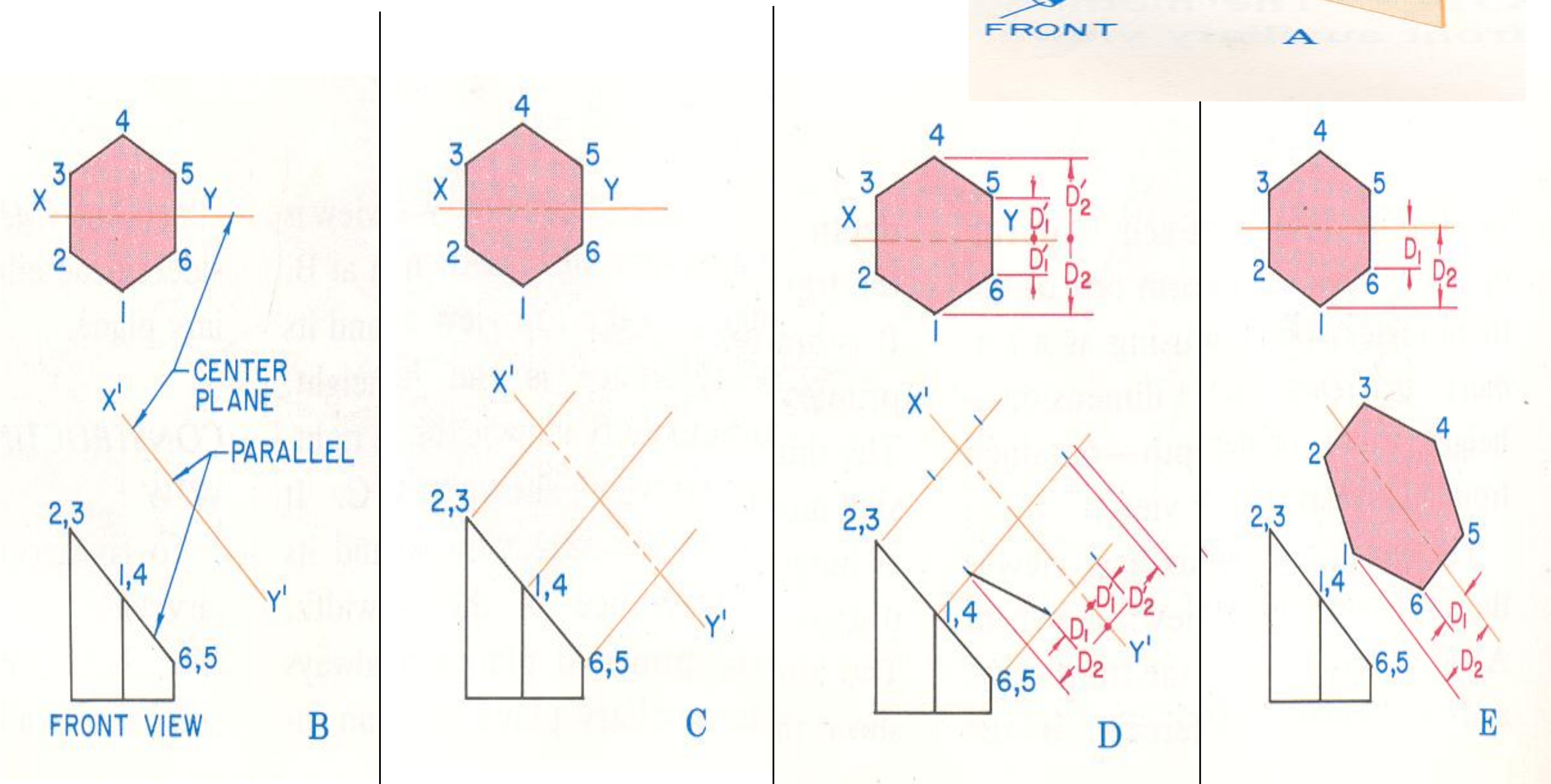
To show **Surface *A*** in its true shape, you need to imagine a plane parallel to it, as in Diagram "B". This is called an ***auxiliary plane***. A view of this plane from the direction of arrow ***X***, which is perpendicular to it, will show the true size and shape of ***Surface A*** at A1. Looking at Diagram "C" this ***auxiliary view*** has been *revolved* (turned) to align with the plane of the paper. By following this method, you can show the true size and shape of any inclined surface.

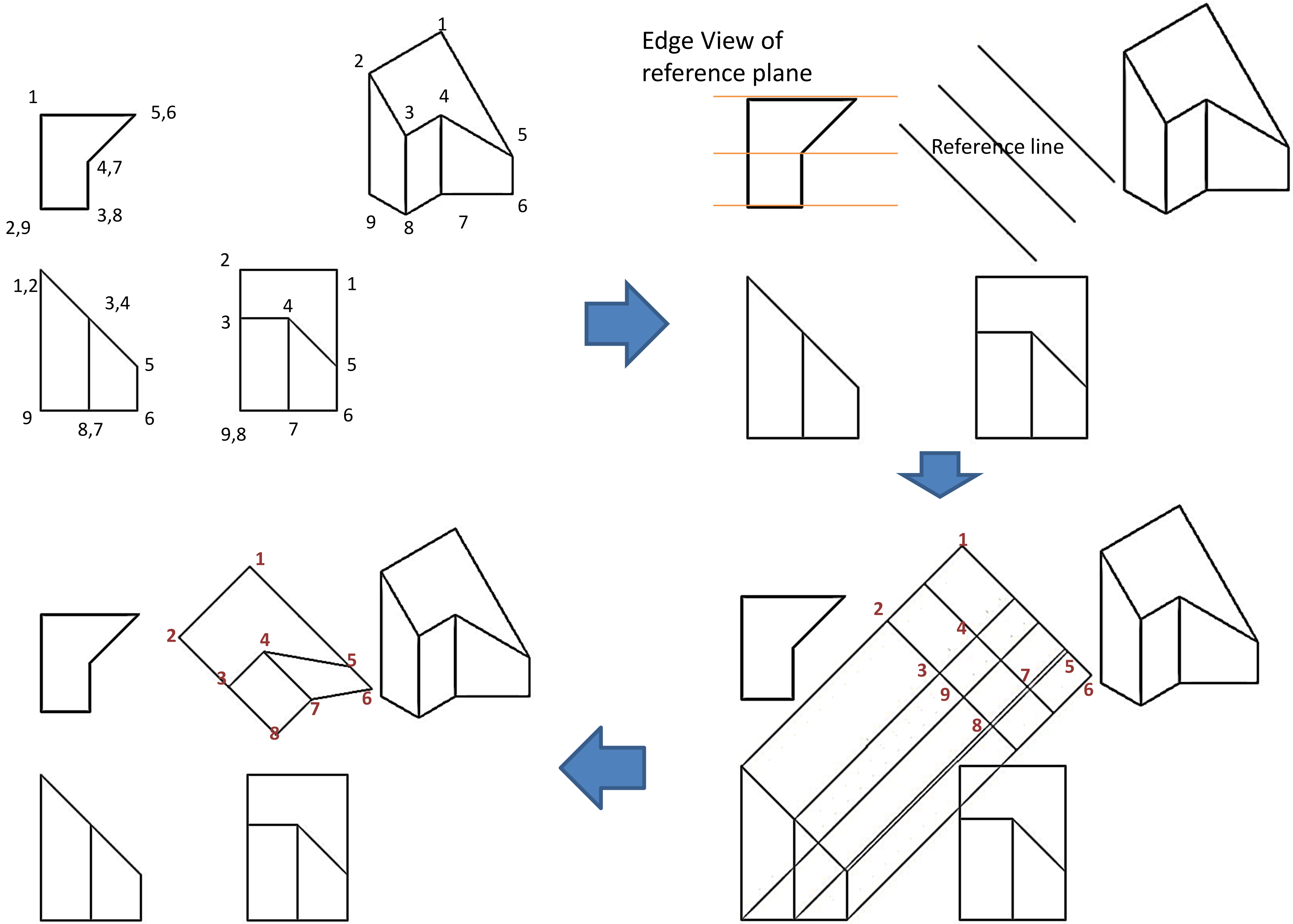




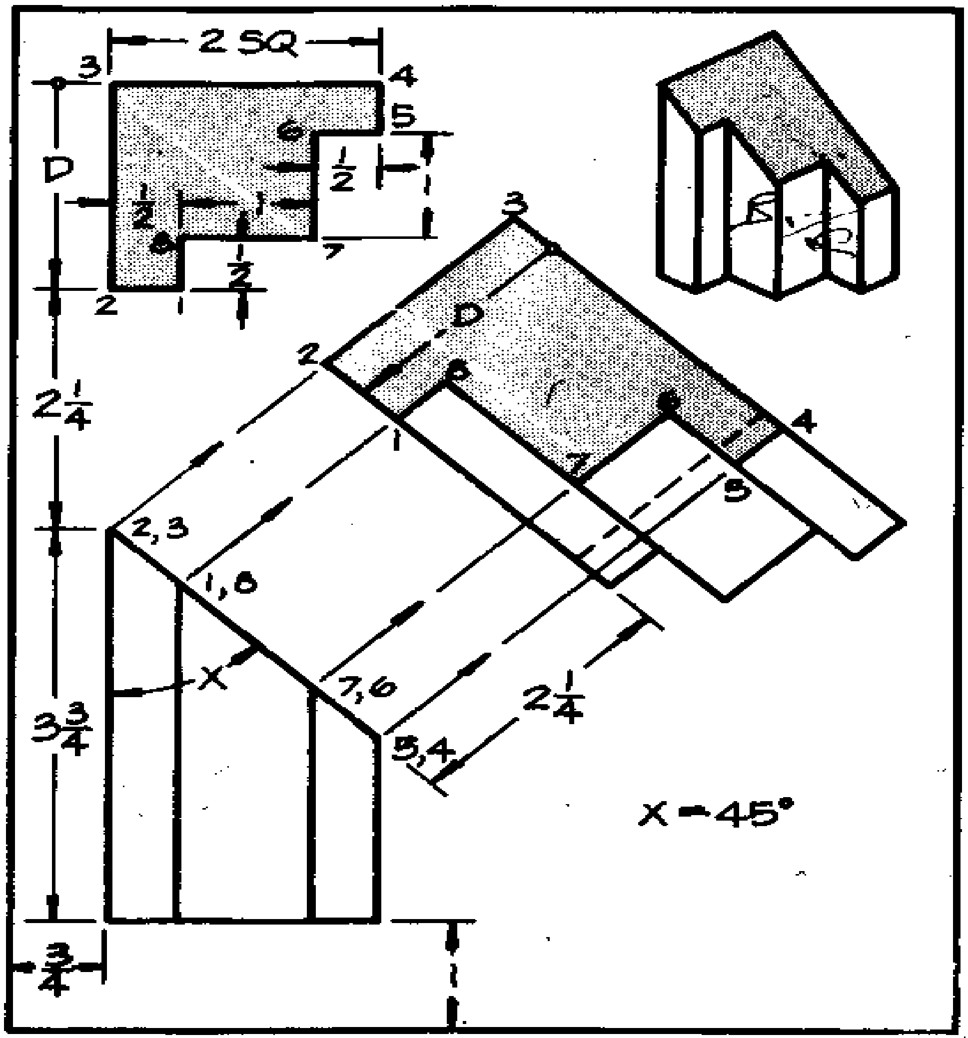
Drawing of an Auxiliary View Using the Center Plane Reference:

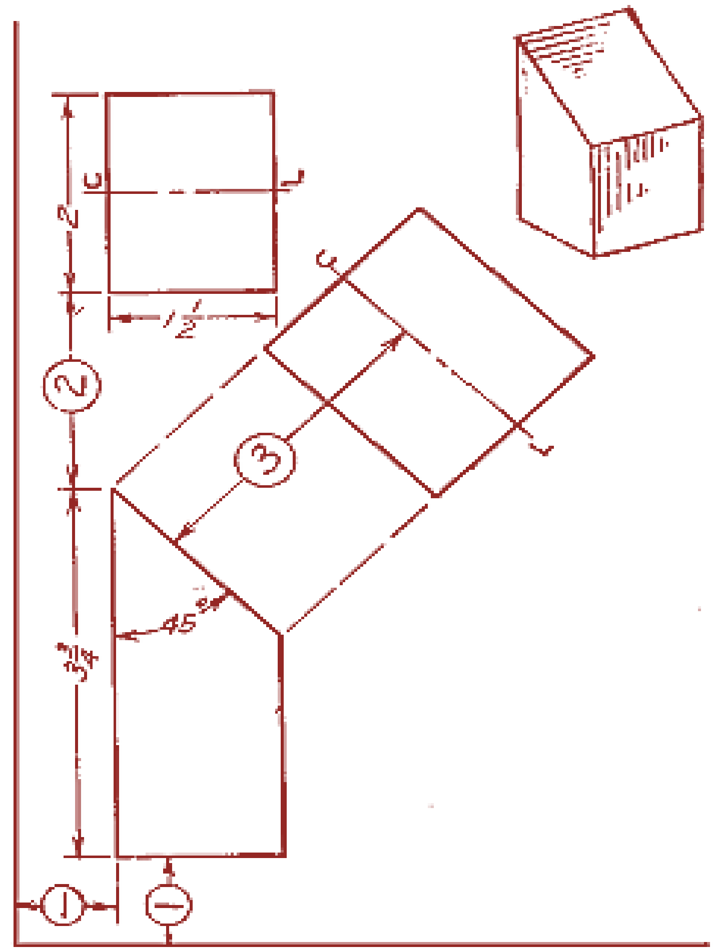





Edge View of
reference plane
Reference line
1
5,6
4,7
3,8
2,9
1,2
3,4
5
9
8,7
6
2
1
3
4
5
6
9,8
7
1
2
3
4
5
6
9
8
7
1
2
4
3
7
5
9
6
8
1
2
4
5
3
6
7
8

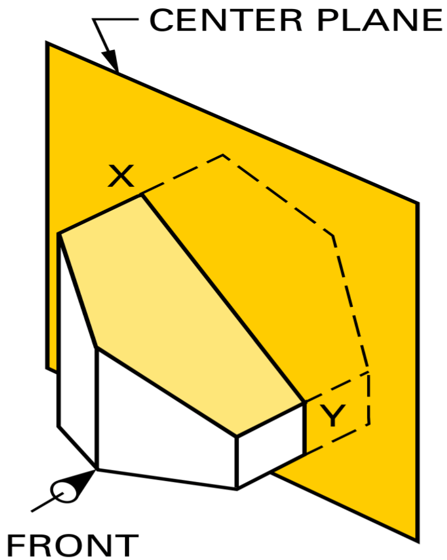
Drawing of an Auxiliary View Using the Center Plane Reference:

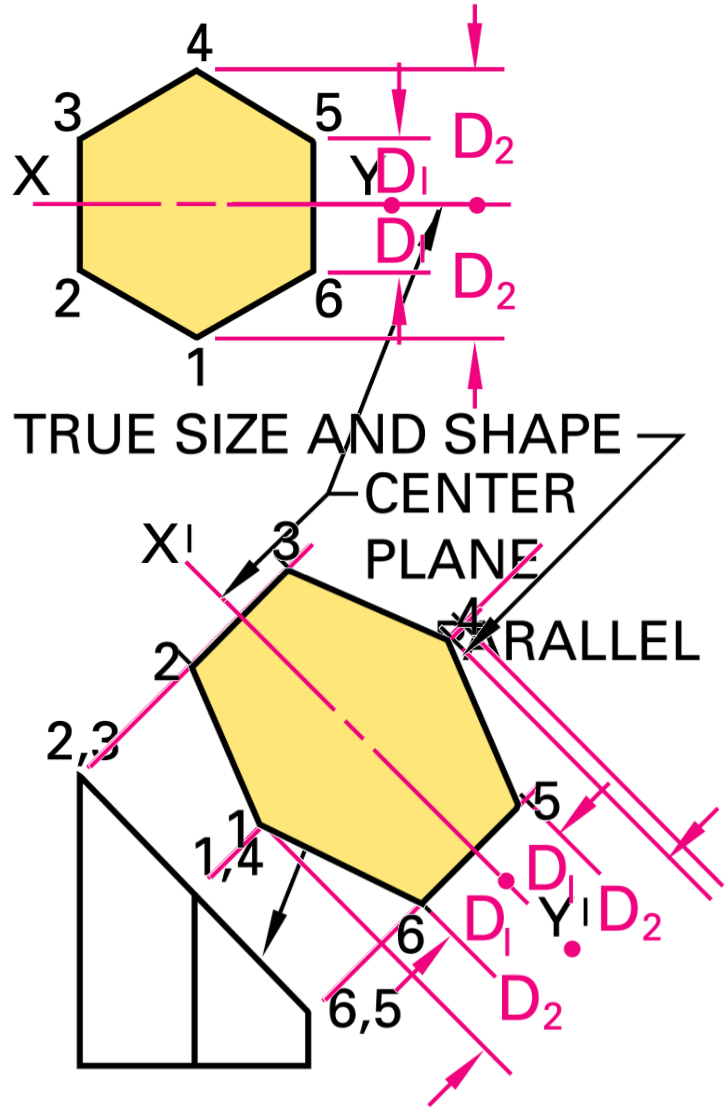




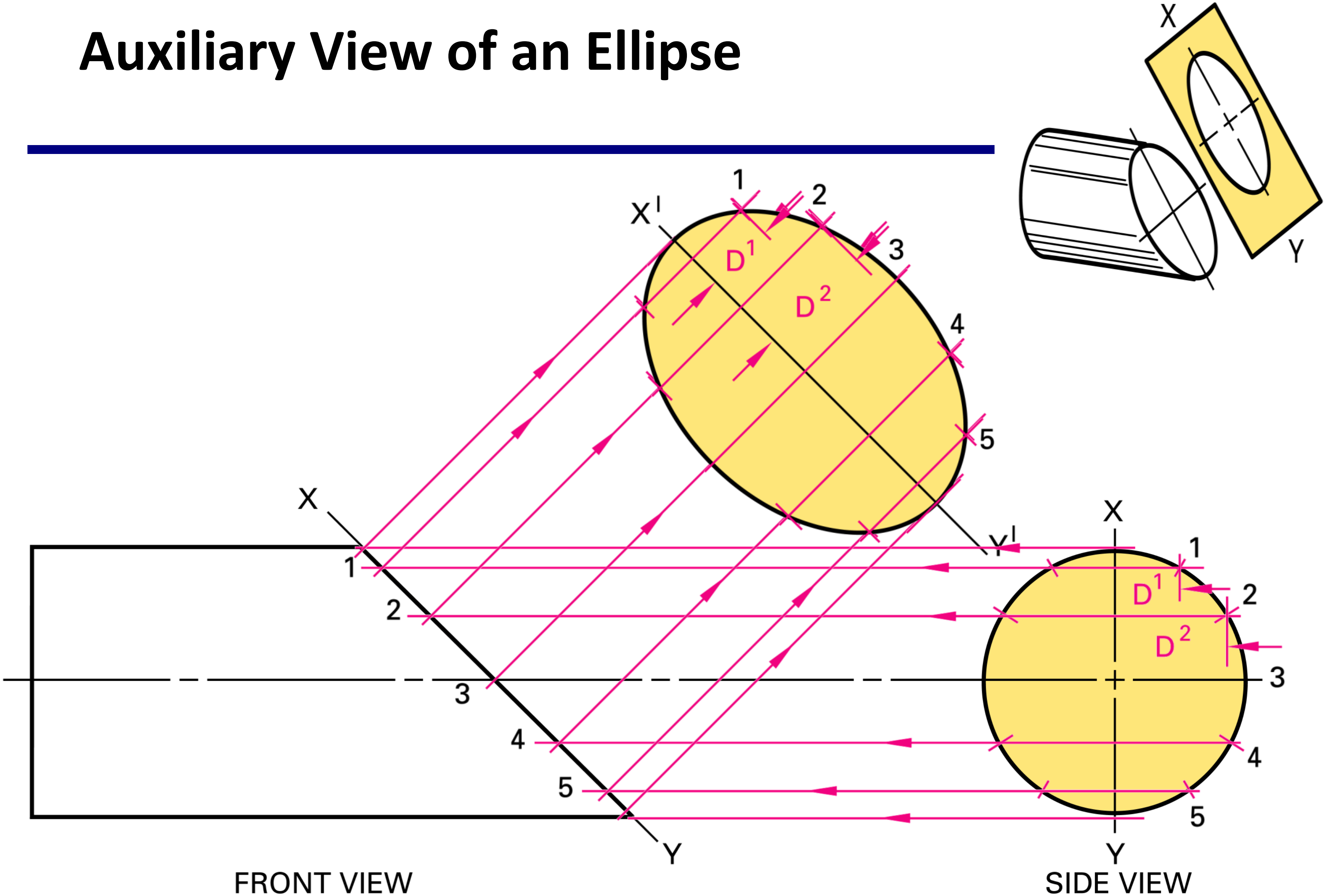
Auxiliary View

Center-Plane Reference Method





Auxiliary View of an Ellipse



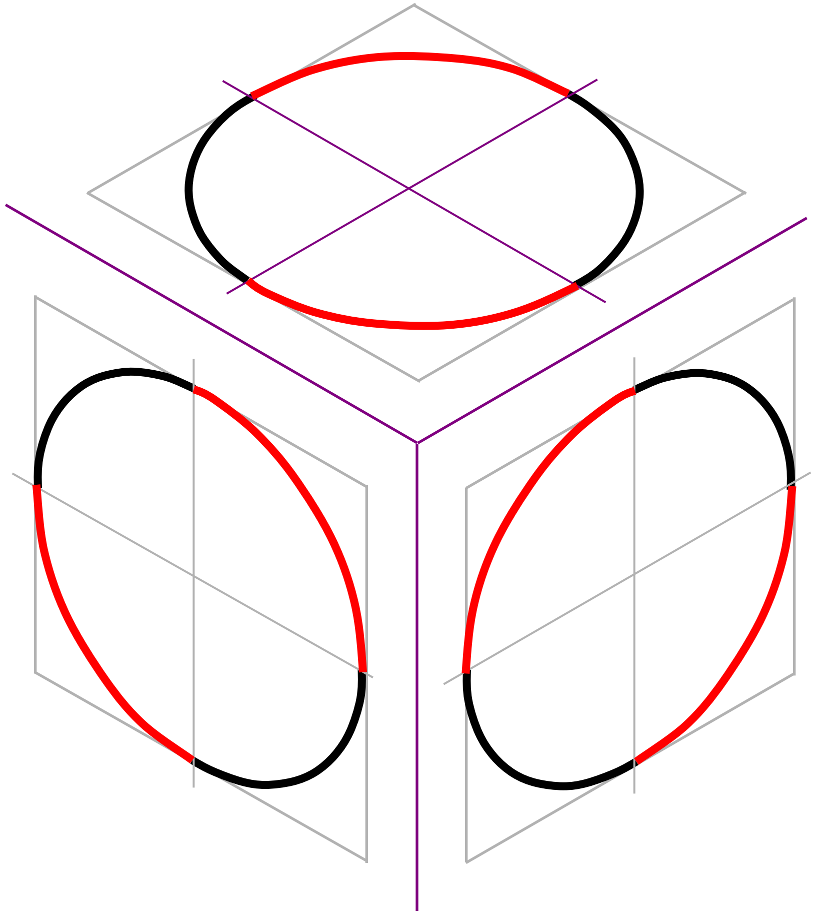
Some Other Techniques to Draw other Items:

Circle & Arc in Isometric

- In isometric drawing, a circle appears as an ellipse.

Sketching Steps

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

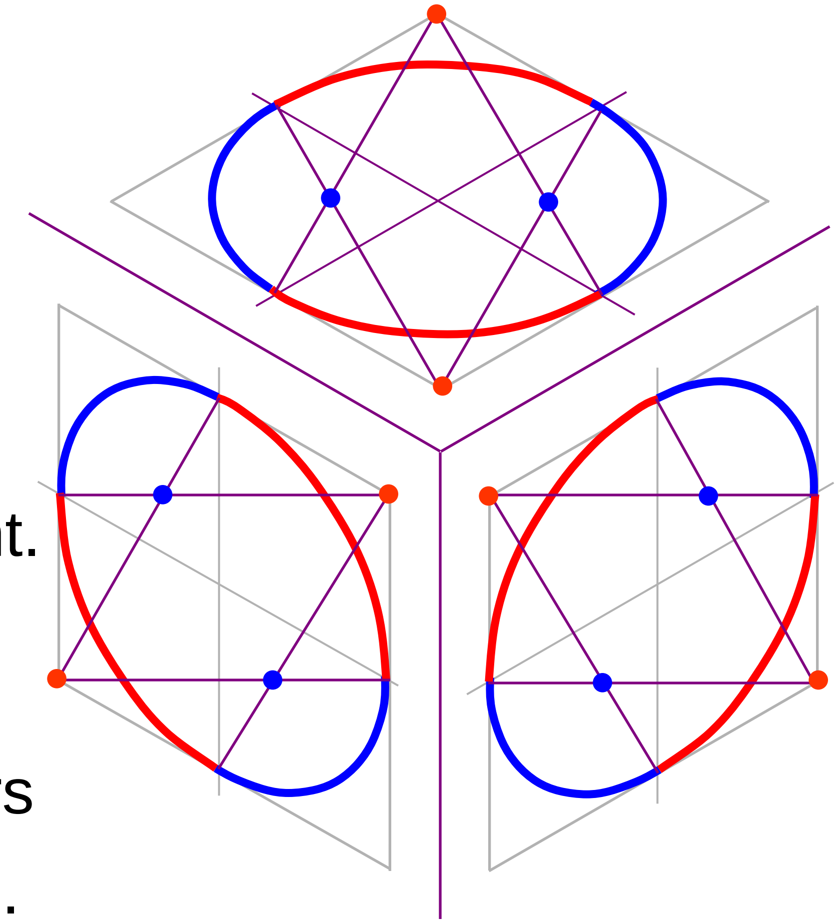


Circle & Arc in Isometric

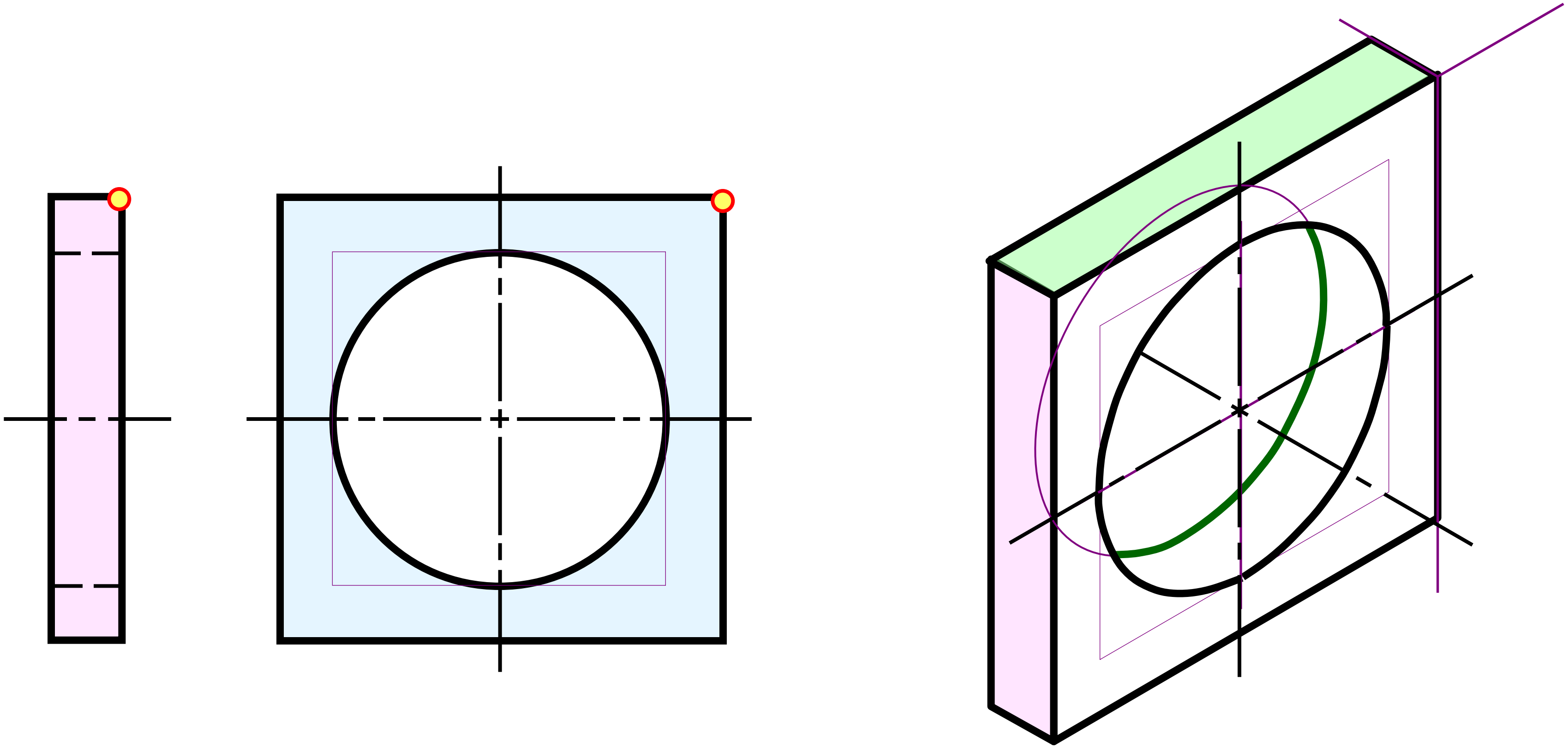
- ***Four-center*** method is usually used when drawn an isometric ellipse with drawing instrument.

Sketching Steps

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



Example 1



Irregular Curve in Isometric

Steps

1. Construct points along the curve in multiview drawing.

2. Locate these points in the isometric view.

3. Sketch the connecting lines.