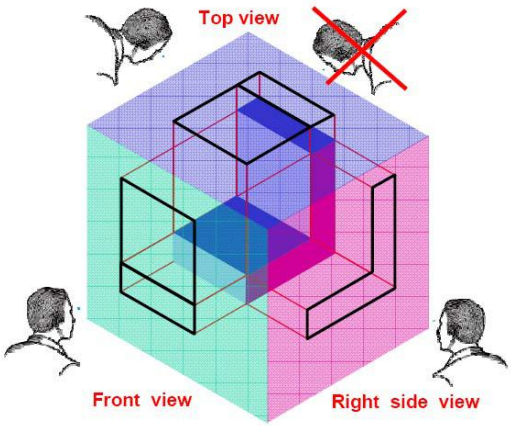
UNIT 6

MULTI-VIEW DRAWING



Learning Competencies:

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

- ✓ Explain the importance of multi-view drawings;
- ✓ Define the concept of projection;
- ✓ Explain the concept of orthographic projection;
- ✓ Identify the three main projection planes;
- ✓ Describe the methods of orthographic projection;
- ✓ Prepare arranged view with first and third angle projection;
- ✓ Identify the six principal views;
- ✓ Arrange the six principal views in 1st and 3rd angle projection methods;
- ✓ Identify the common dimensions of views;
- ✓ Analyze guide lines for orientation and choice of views that most describe an object;
- ✓ Lay out one view, two view, and three view drawings;
- ✓ Prepare the multi – view drawing of an object;
- ✓ Show hidden features of an object;
- ✓ Apply the rule of precedence of line in view drawings;
- ✓ Identify normal, inclined and oblique surface;
- ✓ Apply visualization skills by solid and surface to multi-view drawings.

6.1 Introduction

- *Have you ever seen a building drawn on a blueprint, plan paper? What do you understand from drawing?*

Multi-view drawings are conventional projections of a three dimensional object on a two dimensional plane. Anything which is going to be produced or constructed is based on the proposal given by multi-view drawings. For example, buildings, machines, office equipments and so on. By this projection convention engineers, architects, draftsman can communicate with each other even if they don't speak common language. The basic rules and principles of orthographic projection will be discussed on this chapter.

6.2 Projection

Activity 6.1

1. *What do you understand from the word projection?*
2. *What do you expect is the thing to be projected?*
3. *What do you think is the destination after projection?*

6.2.1 Types of projection

A projection is a drawing of an object which is three dimensional on a two dimensional surface or plane. The two dimensional surface used for the projection is called ***plane of projection*** or the ***picture plane***.

There are different types of projections which are classified depending on:

- The angle the lines of sight (projection line) make with the projection plane,
- The angle the lines of sight make with each other,
- The relative position of the object to be projected with respect to the projection plane.

Projection methods are broadly classified into two: *Parallel projection and Central projection*.

In central projection, the observer is assumed to be located at some finite location. Hence the visual rays projected from the different corners of the object converge to the single point of viewing, this is the actual viewing mechanism and therefore the projection possesses realistic appearance like camera picture. Central projection is commonly called Perspective projection.

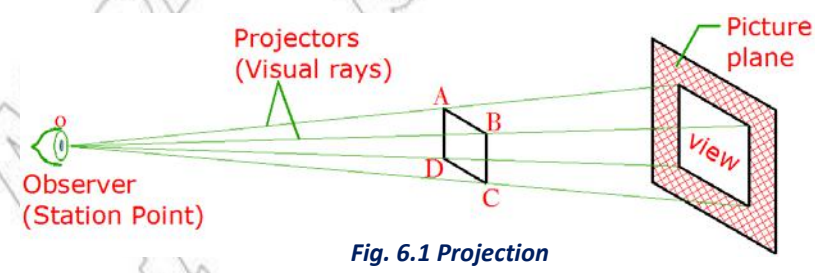


Fig. 6.1 Projection

Perspective projection is further classified as *linear perspective* and *aerial perspective.*
As the observer moves further and further away from the object, the angle between the visual rays reflected from the different corners of the object becomes more and more gentle. If we can therefore place the observer at very large distance from the object we can assume that these visual rays become parallel with each other. Parallel projection is based on the assumption of observer being at large distance without losing the ability to see the object. This assumption will bring about some distortion to the pictorial appearance of the projection as compared to actual appearance.

Parallel projection is further classified into *orthographic* and *oblique projection*. If the lines of sight are parallel to each other and perpendicular to the picture plane, the resulting projection is called an ***orthographic projection.*** If the lines of sight are parallel to each other but inclined to the picture plane, the resulting projection is called an ***oblique projection***. Orthographic projection is further classified into *multi-view projection* and *axonometric projection.*

In multi-view projection more than one projection is used to give complete size and shape description of the object while in axonometric projection a single view is sufficient to describe the object completely.

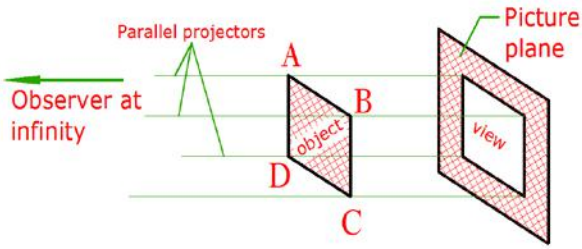


Fig. 6.2 Parallel projection

6.3 Orthographic Projection

1. *What do you think the word orthographic implies? Discuss with your friends.*
2. *How do you expect projection and orthography to be related?*

6.3.1 Planes of Projection

There are three planes perpendicular to each other, which are the basis of multi-view projection. These are:

- Horizontal projection plane.
- Frontal projection plane.
- Profile projection plane.

The position of these planes is illustrated on the figure below (Fig. 6.3). The lines of intersection of these three planes are called reference lines.

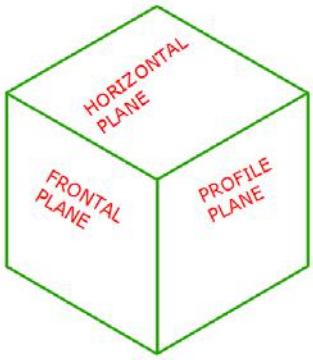


Fig. 6.3 Basic planes of projection

In multi-view projections, lines of sight (projectors) are perpendicular to the planes

of projection. The projection of an object on the vertical/frontal projection plane is commonly known as front view. Similarly, horizontal projection of an object is called top view and the profile projection of an object is known as side view.

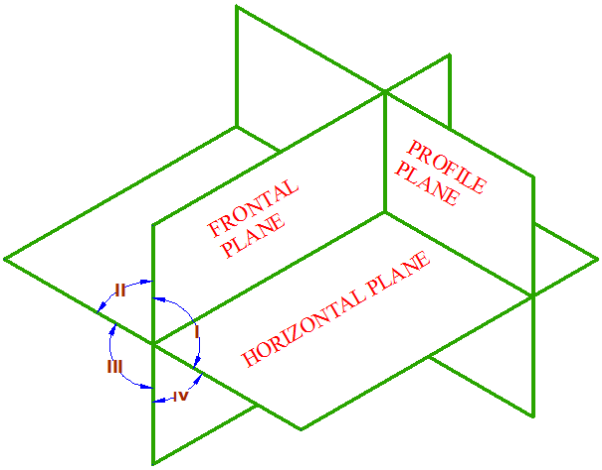


Fig. 6.4 Quadrants of projection

6.3.2 First Angle Projection

The three principal planes of projection form four quadrants (Fig.6.4). The multi-view of an object can be done by placing the object on one of the quadrants. But usually the first and the third quadrants are the conventional quadrants used. When the object is assumed to be placed in the first quadrant it is known as *first angle projection system*. In this case the observer is placed in front of the vertical plane, the object will appear to be between the observer and the projection plane. In Fig. 6.5, the three views of a simple object on the three principal planes of projection are shown pictorially. Then to represent all the views in one plane, the horizontal plane and the profile plane are rotated to the vertical plane as shown in Fig. 6.6. The views are then drawn in their true shape as shown in Fig.6.6 (b). Note that the views are arranged in such a way that the top view is always directed below the front view and the left side view is directly to the right of the front view.

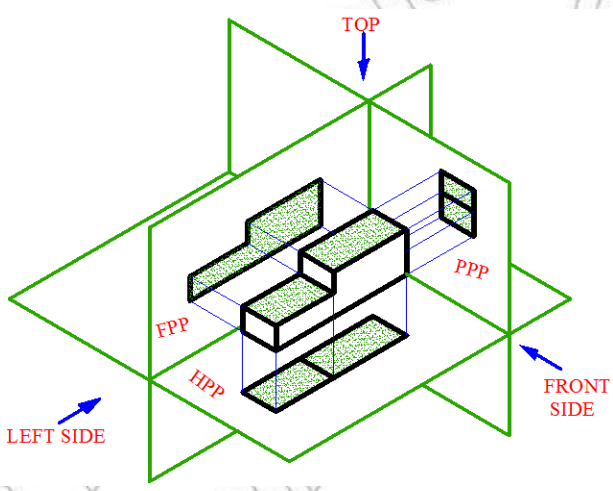
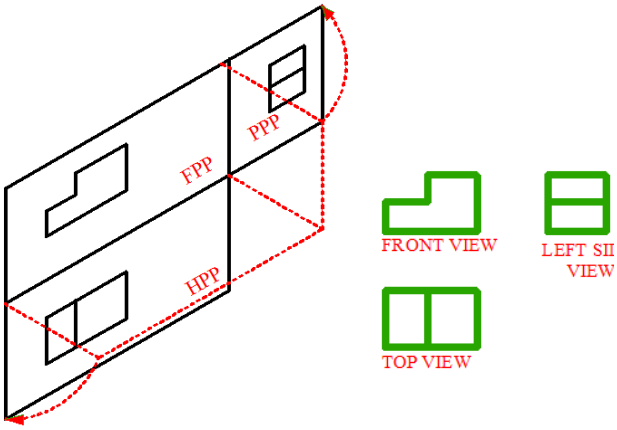


Fig. 6.5 First angle projection



(a) (b)

Fig. 6.6 Projection planes unfolded

6.3.3 Third Angle Projection

When the object is placed in the third quadrant it is known as *third angle projection system*. The projection plane is placed between the observer and the object. Therefore, in the projection process it is necessary to assume the plane of projection to be transparent. Here again the projections are perpendicular to the projection planes.

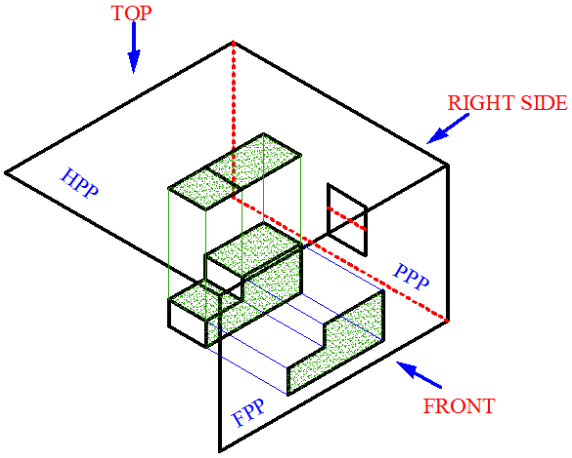
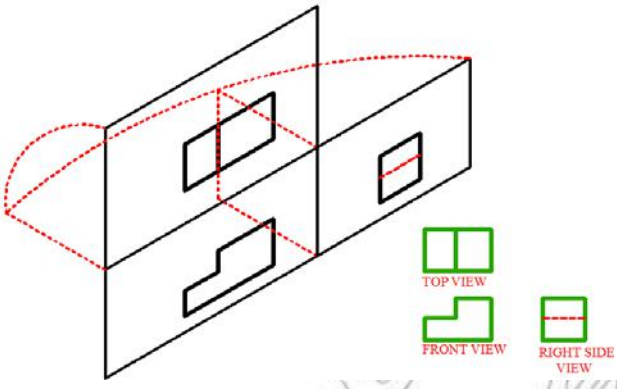


Fig. 6.7 Third angle projection

The figure above illustrates the method of getting the third angle projections of an object. After developing the different views of the object in the different projection planes, all the projection planes are opened up to the frontal projection plane as illustrated in Fig 6.8 (a) and (b).



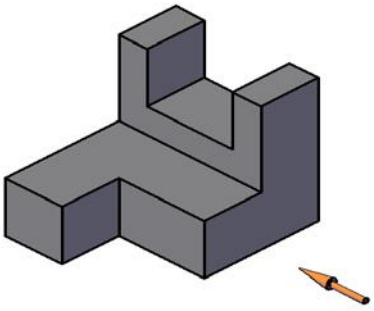
(a) (b)

Fig. 6.8 Projection planes unfolded

Note here that, in the third angle projection system, the top view is placed directly above the front view and the right side view is placed directly to the right of the front view. This relative arrangement of the views is the one which distinguishes multi-view drawings whether they are prepared by the third angle projection system or the first angle projection system.

Checkpoint 6.1

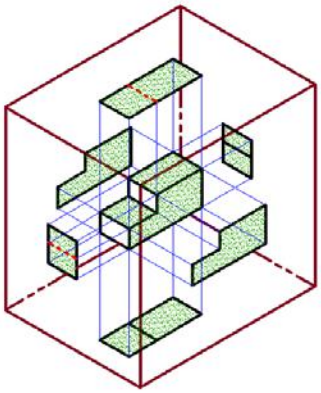
Draw the three views of the object shown in the figure using both first angle and third angle projection systems. (use 2:1 scale)



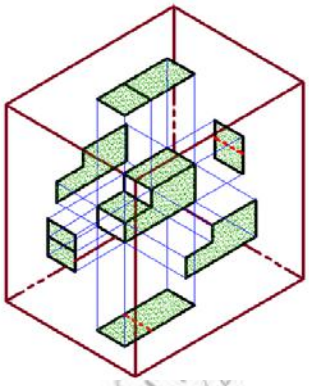
6.4 The Six Principal Views

1. *Look at your class room and observe the planes or walls in different direction.*
2. *After this count the walls including the ceiling and the floor.*
3. *How many planes (wall, ceiling or floor) did you count?*

Extending the above discussion, the object can be thought of as being surrounded by a box or a set of six planes which are mutually perpendicular to each other as shown in Fig.6.9. The views projected onto these six planes are called *six principal views*. Their designations are given in table 6.1.



(a) First angle projection



(b) Third angle projection

Fig. 6.9 First and third angle projection

Table 6.1 Designation of the six principal views

Direction from which View is taken (fig 6.10)	Name of view
View in direction A	Front view
View in direction B	Top view
View in direction C	Left side view
View in direction D	Right side view
View in direction E	Bottom view
View in direction F	Rear view

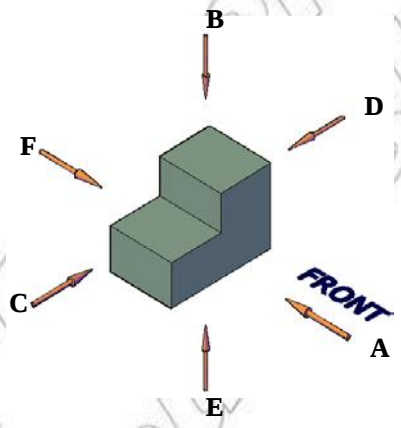


Fig. 6.10 Given object

The relative positions of these six views in the first angle and third angle projections for the object in Fig. 6.10 are shown in Figs. 6.11 and 6.12, respectively. It may be noted that in both projections, the rear view can be placed either on the left or on the right as convenient.

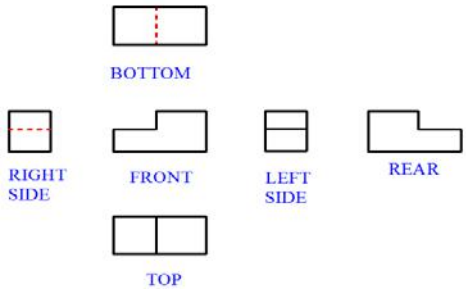


Fig. 6.11 The six principal views and their arrangement in first angle projection

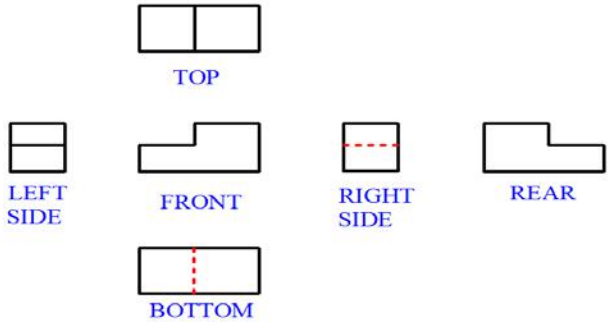


Fig. 6.12 The six principal views and their arrangement in third angle projection

6.4.1 Alignment of Views

The alignment and the orientation of the views made by the first or third angle have certain rules.

- The front view, top view and bottom view are always aligned vertically
- The front, left side, right side and rear views are in line horizontally. Note that the rear view may be placed next to either the right side view or left side view where found convenient.

6.4.2 Common Dimensions

When we are dealing on multi-view projection it is true that two views will have the same edge projected on. Here are some facts of edges which have common dimensions.

- The depth of the top view is the same as the depth of the side view(s).
- The width of the top view or bottom view is the same as the width of the front view or rear view.
- The height of the side view(s) is the same as the height of the front view or rear view.

6.4.3 Adjacent Placement of Views

Since there is a size relation between the multi-views, it is proper to draw views which share the same edge adjacently. Here are the placements of views according to their relation.

- The top view should be drawn below the front view if first angle projection is used and above the front view if third angle projection is used.
- The bottom view should be drawn above the front view in the first angle projection system and below the front view in the third angle projection system.
- The right side view should be drawn to the left of the front view in the first angle projection system and to the right of the front view in the third angle projection system.
- The left side should be drawn to the right of the front view if first angle projection is used and to the left of the front view if third angle projection is used.

Example: Draw the six principal views of the given object in the first angle projection.

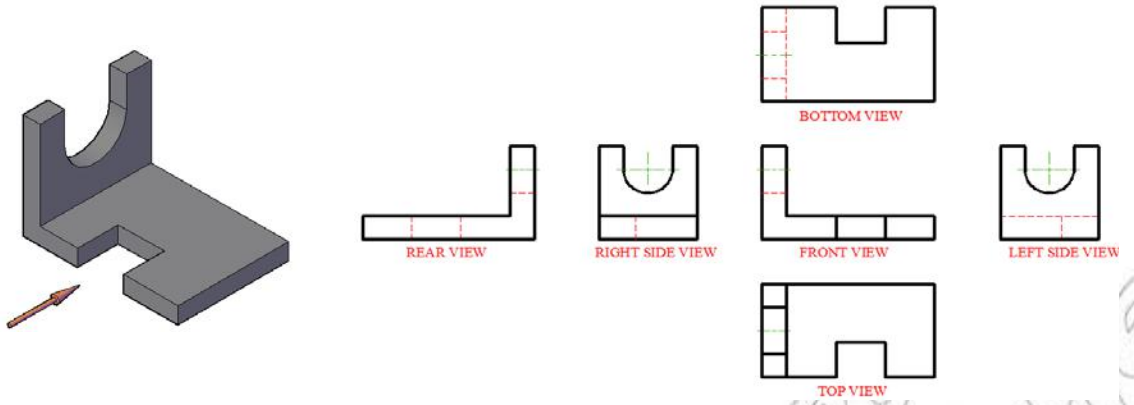
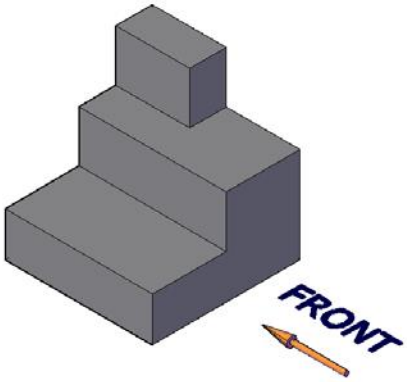


Fig. 6.13The six principal views of a given object

Checkpoint 6.2

Draw the six principal views of the object whose pictorial drawing is given in the figure using both the first and third angle projection systems. (use 1:1 scale)



6.4.4 Orientation of the Object and Choice of Views

Activity 6.2

1. *Have you observed that an entrance of any building is oriented in such a way that it Is easily accessible and visible?*
2. *Based on this idea observe buildings and their entrances with respect to orientation and present some examples to the class in group.*

Observe that some of the six views of an object may be enough to represent the object completely. Note the following points to determine the essential views for the complete description of the object.

i. Orientation of the object

- Place the object in its most natural (stable) position.
- Place the object with its main faces parallel to the planes of projection.

ii. Choice of views

- Select those views (in addition to the front view) that provide the clearest information about the shape of the object.
- Do not use more views than the necessary views which describe the object.
- If the left side and right side views are identical in terms of information and line work, select the view to be drawn to the right of the front view, in accordance with tradition.
- If the top view and bottom view are identical in terms of information and line work, select the top view.
- If the top and side views are identical in terms of information and line work, select the one that best utilizes the available drawing space.
- If two views are identical in terms of information, but one contains more hidden line work than the other, select the view with fewer hidden lines.

Example Consider the simple object whose six principal views were given in Fig. 6.11. The front view is necessary and should be drawn always. Then, the rear view is not necessary since it shows no additional information. The left side view is preferred to the right side view because there is no hidden line in the left side view. The top view is preferred to the bottom view because there is no hidden line on the top view. Therefore, the three necessary views of the object are the front, top and left side views as shown in Fig. 6.14.

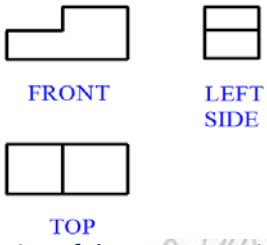


Fig. 6.14 Selection of the necessary views

Example Let us consider the object whose six views were shown in Fig 6.13. The right side view is preferred to the left side view because it has less number of hidden lines. Likewise, the top view is preferred to the bottom view.

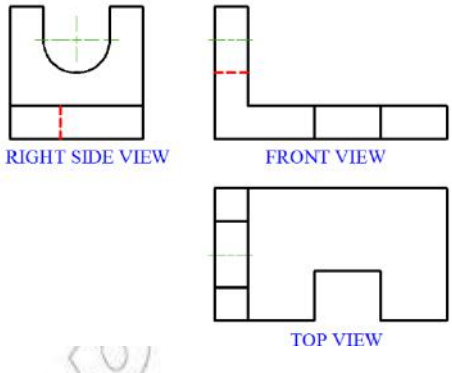
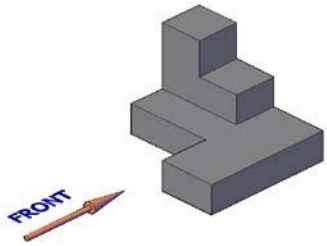


Fig. 6.15 Selection of necessary view

Checkpoint 6.3

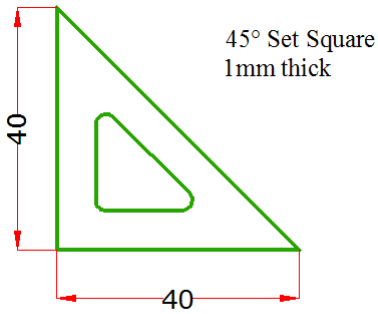
Draw the six principal views of the object given and cross out the unnecessary ones.



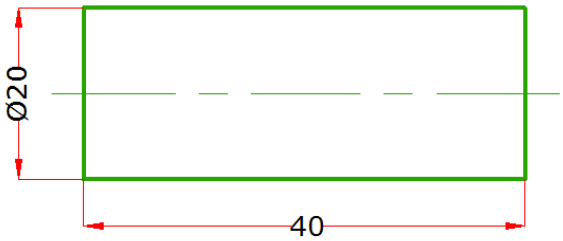
6.4.5 One and Two View Drawing

One view drawings

One view drawings are drawings that consist of one view of the object with additional notes. These drawings are often suitable to represent flat and cylindrical objects. For example, constant thickness parts such as shown in Fig.6.16(a) can be represented by a single view showing the characteristic shape. The thickness is specified by a note adjacent to the view. Fig.6.16(b) shows another example on a cylindrical object which can be represented by a single view. The single view shows the axis of the cylindrical part as a center line, and the diameter symbol (Ø) along with the diameter dimensions.



(a) One-view drawing of a flat part



(b) One-view drawing of a cylindrical part

Fig. 6.16 Example of one-view drawings

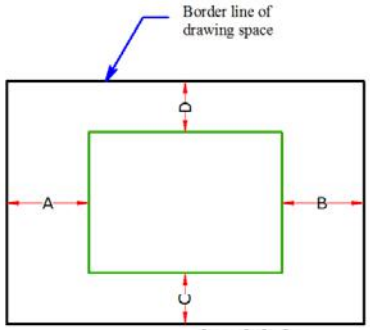


Fig. 6.17 Laying out one view drawing

Two view drawings

On some objects only two of the views might represent the outline clearly. In such cases only the front view and one additional side or top view will be enough to describe the object completely. These views should be selected in accordance with the guidelines discussed in section 6.4.4.

To lay out one view and two view drawings centrally, the distance between the object and the borderline is necessary and it can be laid as follows. A = B and C = D (Fig. 6.17 and 6.18)

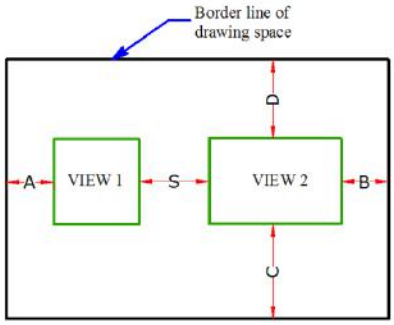


Fig. 6.18 Laying out two view drawing

Fig. 6.19 shows different objects which can be completely described using two views. Such drawings are called two-view drawings.

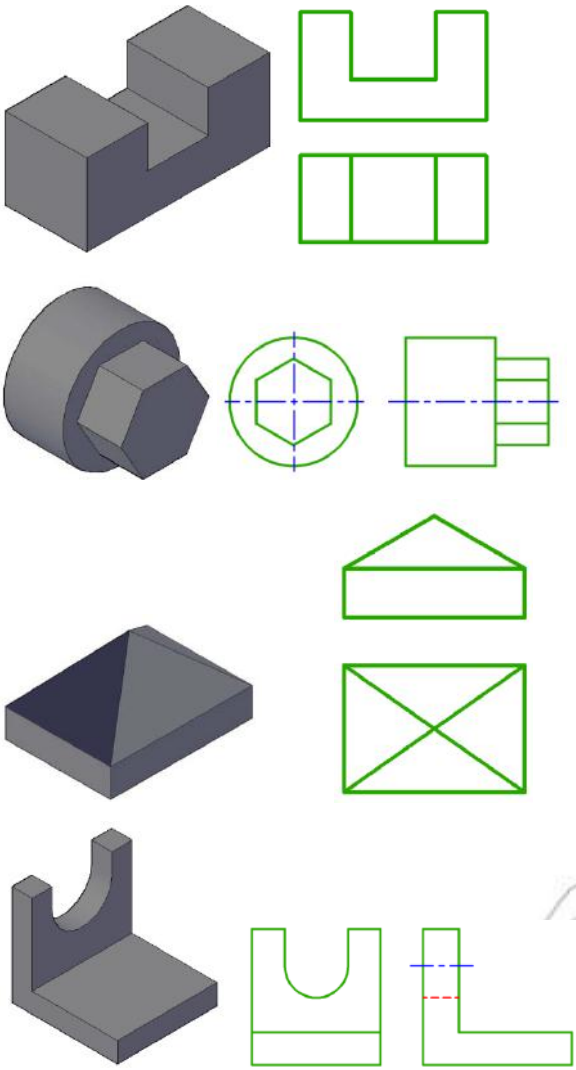


Fig. 6.19 Examples of two view drawings

6.4.6 Three-View Drawing

Three-view drawings are multi-view drawings that consist of three views of an object. These drawings are prepared for objects which require three views for their complete description. Fig.6.20 shows a typical example of an object which requires three views.

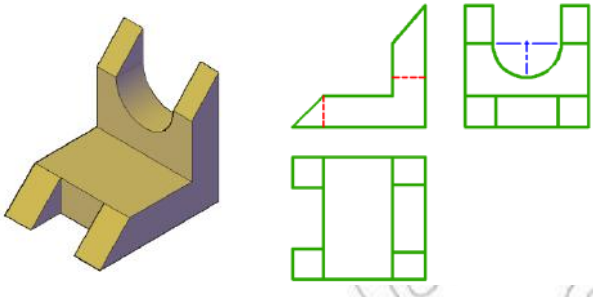


Fig. 6.20 An example of a three-view drawing

To lay out a three-view drawing on a given drawing space, the three views should be spaced as illustrated in Fig. 6.21. Note that length A and C should be equal, length E and F should be equal and length S1 and S2 should be equal. However S1 or S2 will be set depending on the available space and appearance.

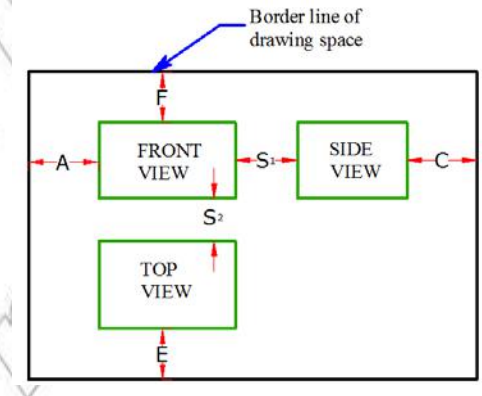


Fig. 6.21 Laying out a three view drawing

6.4.7 Invisible Lines and Arcs

Invisible edges in multi-view drawings are represented by dashed or hidden lines. When drawing views of objects, invisible lines and visible lines may intersect. Hidden lines may also intersect each other. In such case lines should be drawn according to the correct practices shown in Fig.6.22.

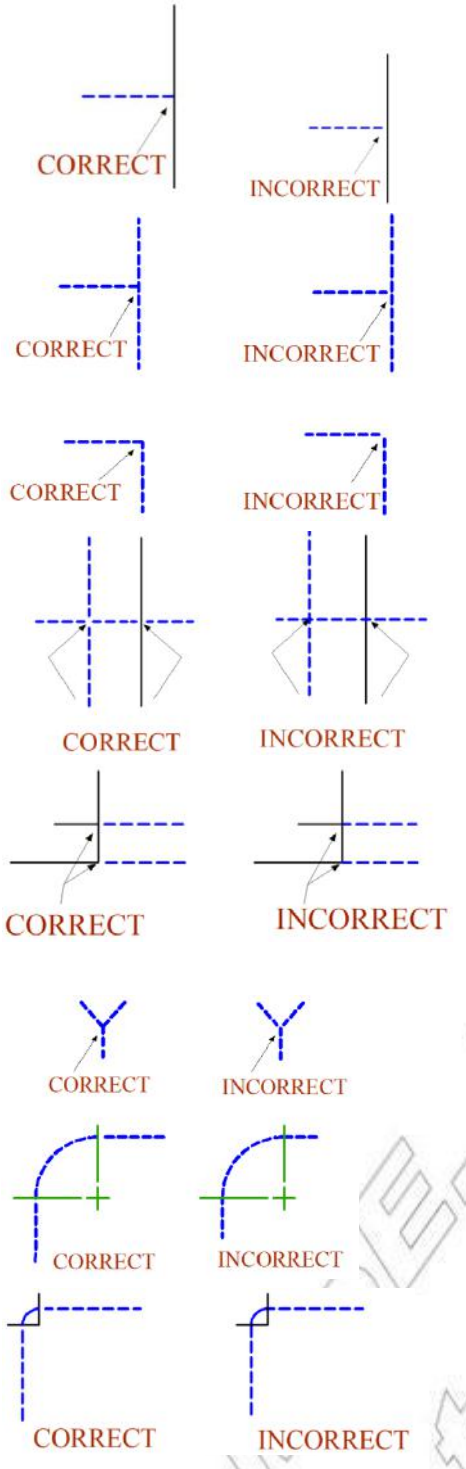


Fig. 6.22 Correct and incorrect practice of drawing invisible lines and arcs

6.4.8 Precedence of Lines

When two or more lines of different type coincide (overlap), the following order of priority should be observed.

1. Visible lines
2. Hidden lines
3. Centre lines
4. Projection lines

Fig.6.23 illustrates the precedence of lines when drawing view of objects.

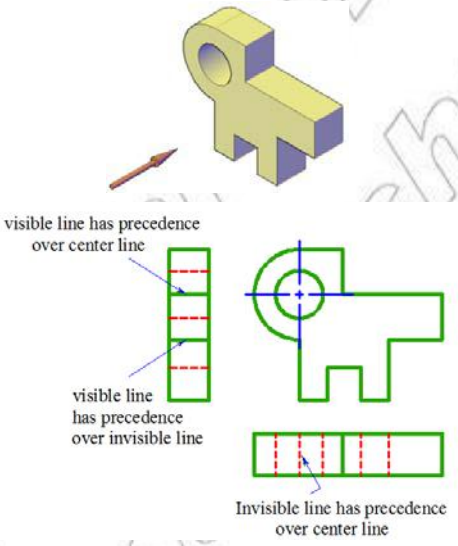


Fig. 6.23 Precedence of lines

6.5 Fundamental Views of Edges and Surfaces

6.5.1 Normal Surfaces

1. *Notice a vertical wall and observe its angular relation with the ground. What angle does it make?*
2. *Imagine the wall in different angle from what you observed. Can you give an example of such a wall on a building you saw in your surrounding?*
3. *How do you expect projection of curved surfaces like cylinders?*

A normal surface is one that is parallel to a principal of projection. If a normal surface is parallel to the frontal plane of projection, it will be shown in its true size and shape on the front view but as a line in the top and side view. If a surface is parallel to the horizontal plane of projection, it will be shown in its true size and shape on the top view and as a line on the other two principal planes. In a similar manner the side view will show the true shape and size of a surface which is parallel to the profile projection plane. Projections of normal surfaces are illustrated in Fig.6.24. Fig.6.25 shows few examples of objects having normal surfaces.

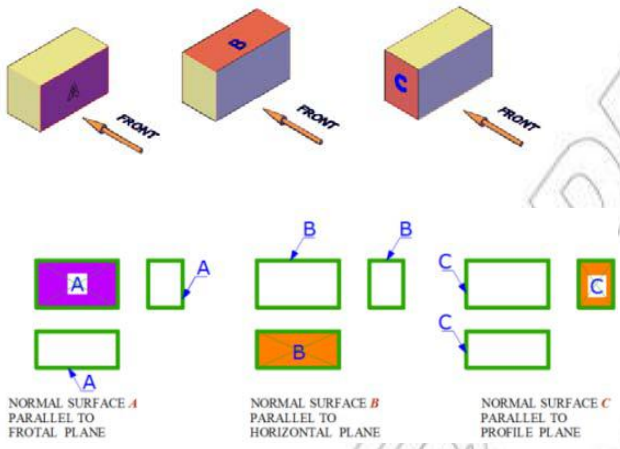


Fig. 6.24 Normal surfaces

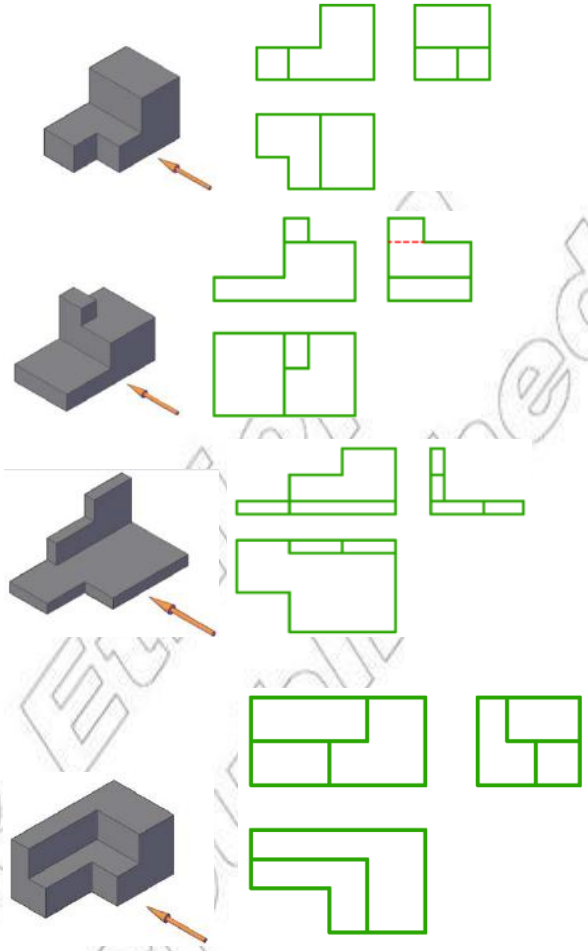


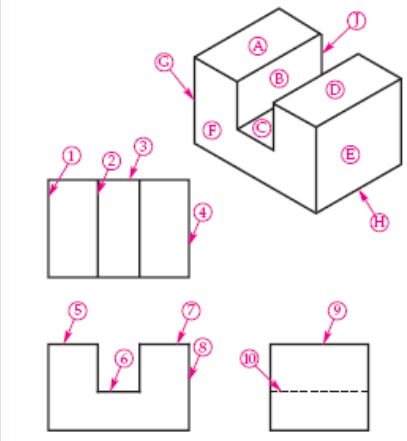
Fig. 6.25 Examples of objects having normal surfaces

Activity 6.3

Normal Surfaces

- ***Study each pictorial (3D) drawing and the identification letters placed on, or pointing to, the normal surfaces. Match the ID letter to the corresponding number for each of the multi-view (orthographic) callouts.***

Note: ***The letter I is not used and in the pictorial view, arrows pointing directly to a line are referencing a surface that is not visible, rather "around the back" of the object.***



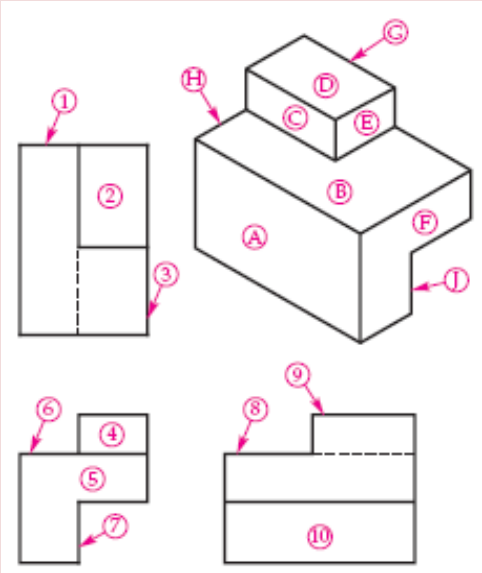
_____1. _____6.

_____2. _____7.

_____3. _____8.

_____4. _____9.

_____5. _____10.



_____1. _____6.

_____2. _____7.

_____3. _____8.

_____4. _____9.

_____5. _____10.

6.5.2 Inclined Surfaces

Inclined surfaces are surfaces which appear perpendicular to only one of the three projection planes. The projection of an inclined surface will be a line on the plane to which it is perpendicular. And it will appear foreshortened on the planes to which it is inclined. The degree of foreshortening is proportional to the angle of inclination. Projections of inclined surfaces are illustrated in Fig. 6.26. Fig.6.28 shows some additional examples of objects having inclined surfaces.

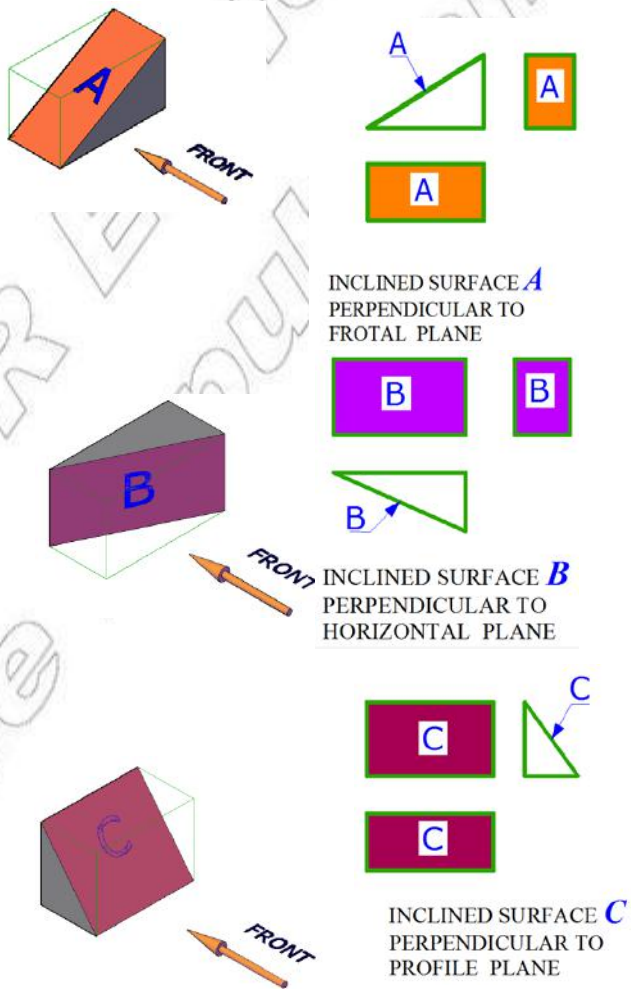


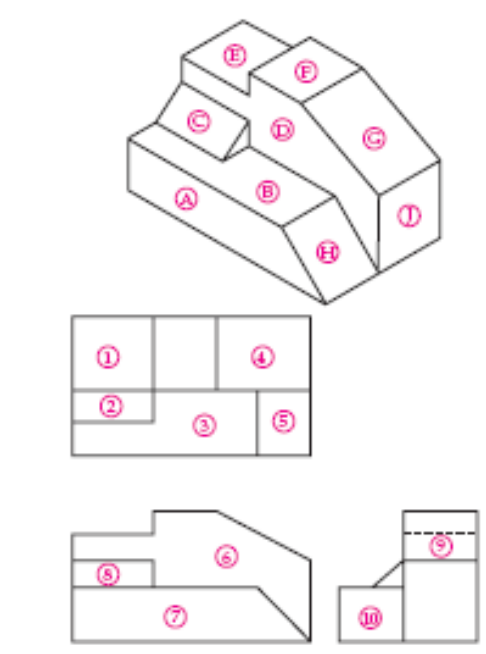
Fig. 6.26 Projection of inclined surfaces

Activity 6.4

Normal and Inclined surfaces

- ***Study each pictorial (3D) drawing and the identification letters placed on, or pointing to the normal or inclined surfaces. Match the ID letter to the corresponding number for each of the multi-view (orthographic) callouts.***

Note: ***The letter I is not used and in the pictorial view, arrows pointing directly to a line are referencing a surface that is not visible, rather "around the back" of the object.***



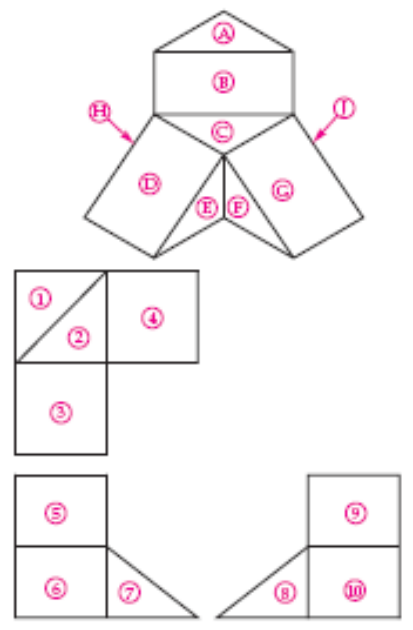
_____1. _____6.

_____2. _____7.

_____3. _____8.

_____4. _____9.

_____5. _____10.



_____1. _____6.

_____2. _____7.

_____3. _____8.

_____4. _____9.

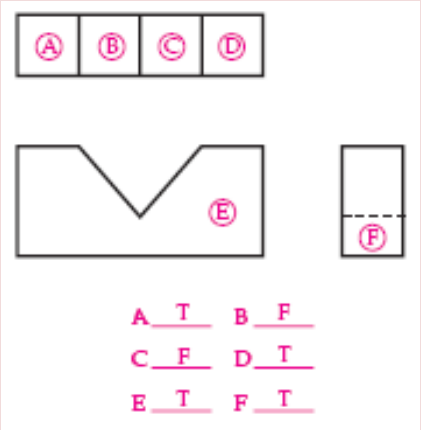
_____5. _____10.

Activity 6.5

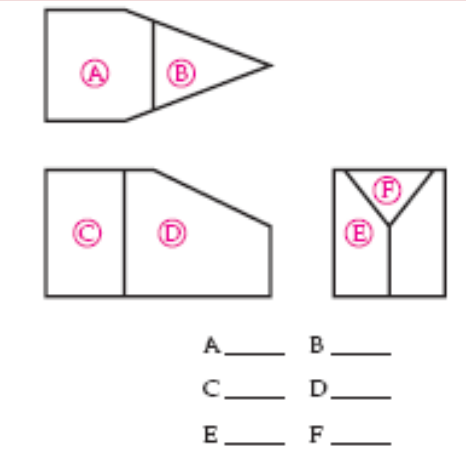
The size and shape identification

- ***Analyze each of the multi-view drawings. Place a T for true size and shape or an F for foreshortened size and shape in the blanks below each multi-view. Remember, normal surfaces appear true size and shape in only one view. Inclined surfaces appear foreshortened in shape and size in two views. The first problem is done for you as an example.***

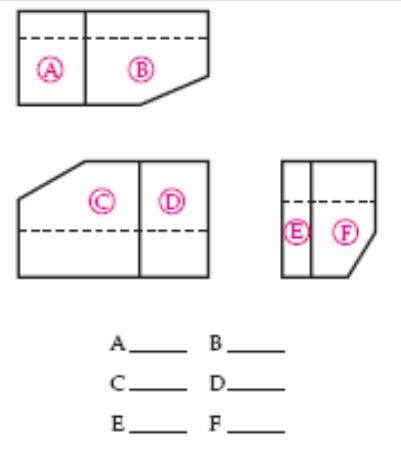
1.



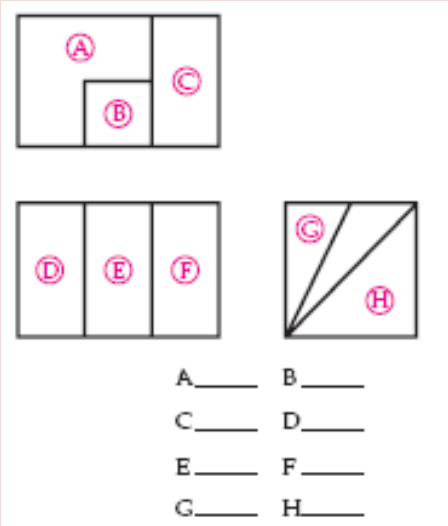
2.



3.



4.



6.5.3 Oblique Surfaces

When a plane surface is inclined to all the three principal planes of projection, it is known as oblique surface. Such surfaces will appear foreshortened in all the principal planes. Projection of an oblique surface is illustrated in Fig. 6.27. Examples of objects with oblique surfaces are given in Fig. 6.29.

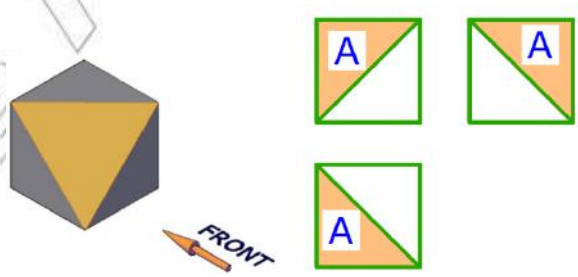


Fig. 6.27 Projection of oblique surface

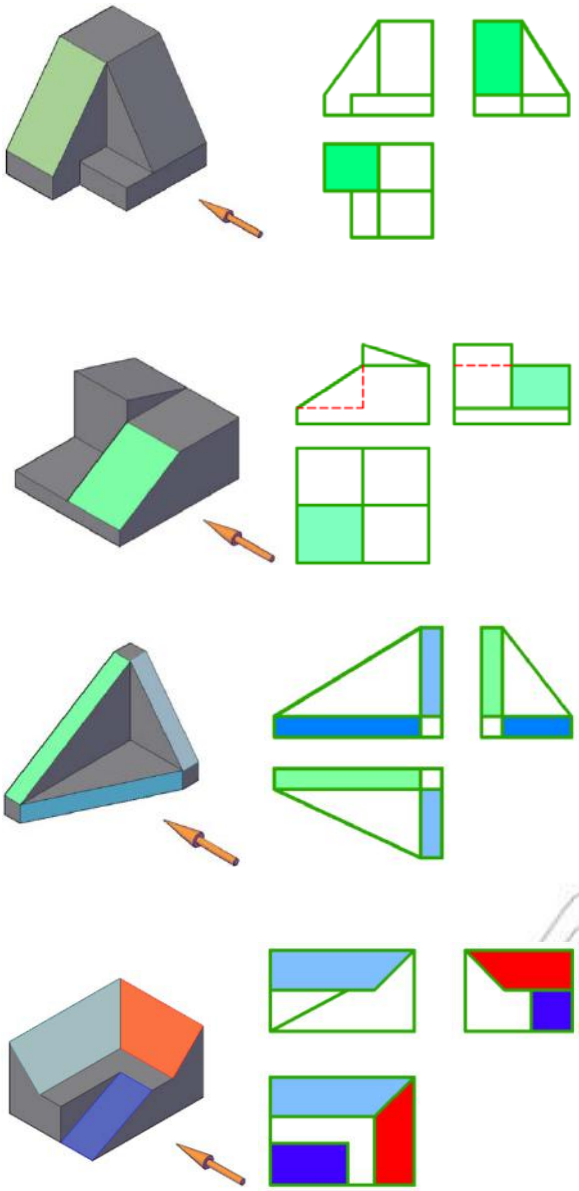


Fig. 6.28 Examples of objects having inclined surface

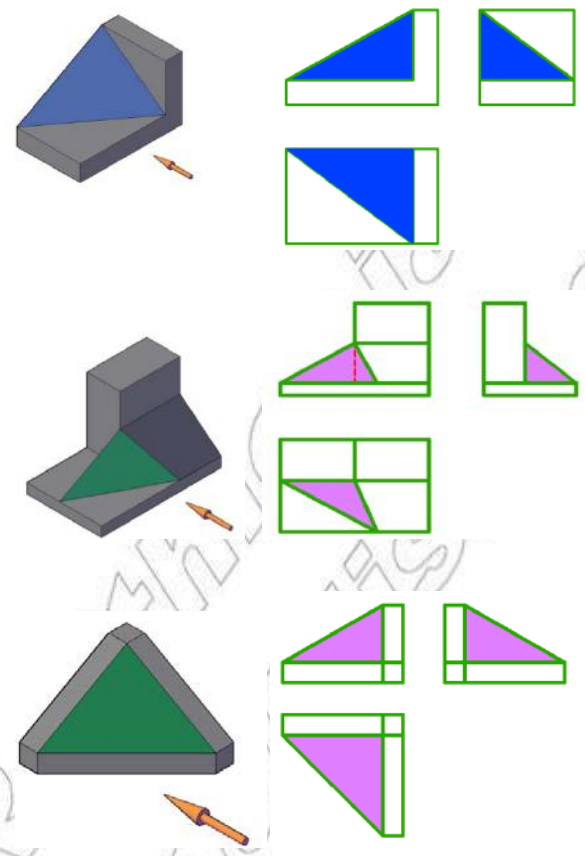


Fig. 6.29 Examples of objects having oblique surfaces

6.5.4 Curved Surfaces

A curved surface is one whose edge view is curved. Such surfaces as cones, cylinders, and spheres often form the exterior or interior of objects. The projection of a cylinder would be a circle in one view and a rectangle on the adjacent view. A sphere would be a circle in every view. A cone will be a circle on one view and a triangle on the adjacent view as shown in Fig.6.30.

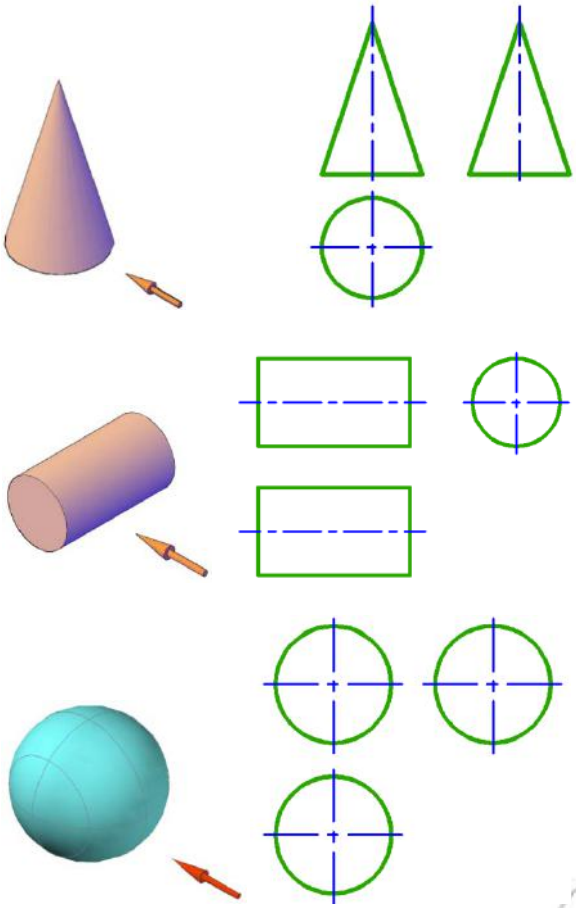


Fig. 6.30 projection of curved surfaces

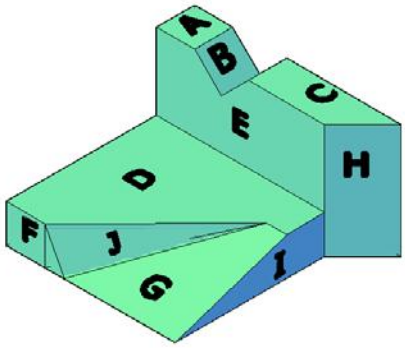
6.6 Visualization

The mental process of forming the image of an object from its orthographic views is called ***visualization.*** The ability to visualize can be developed by consistent practice. To improve visualization, the principle of orthographic projection can be applied to the following types of exercises:

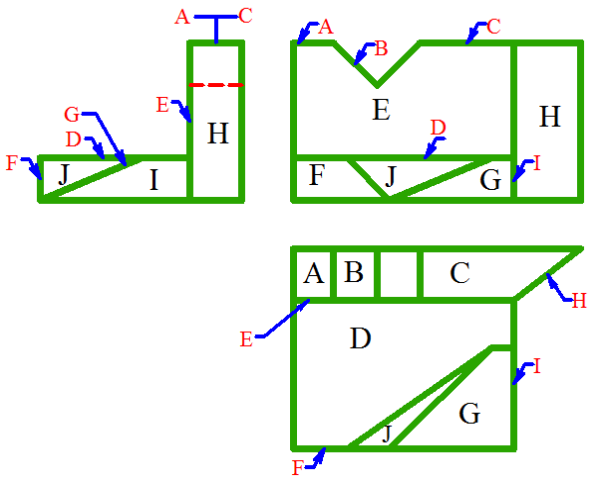
1. Identification of surfaces
2. Missing line problems
3. Possible view problems
4. Missing or third view problems

1. Identification of surfaces

The pictorial drawing and multi-views of an object in which the planes are indicated with letterings are given below. The surfaces are matched on the pictorial drawing and multi-view drawing using letters. (Fig.6.31)



(a) Pictorial drawing of the given object

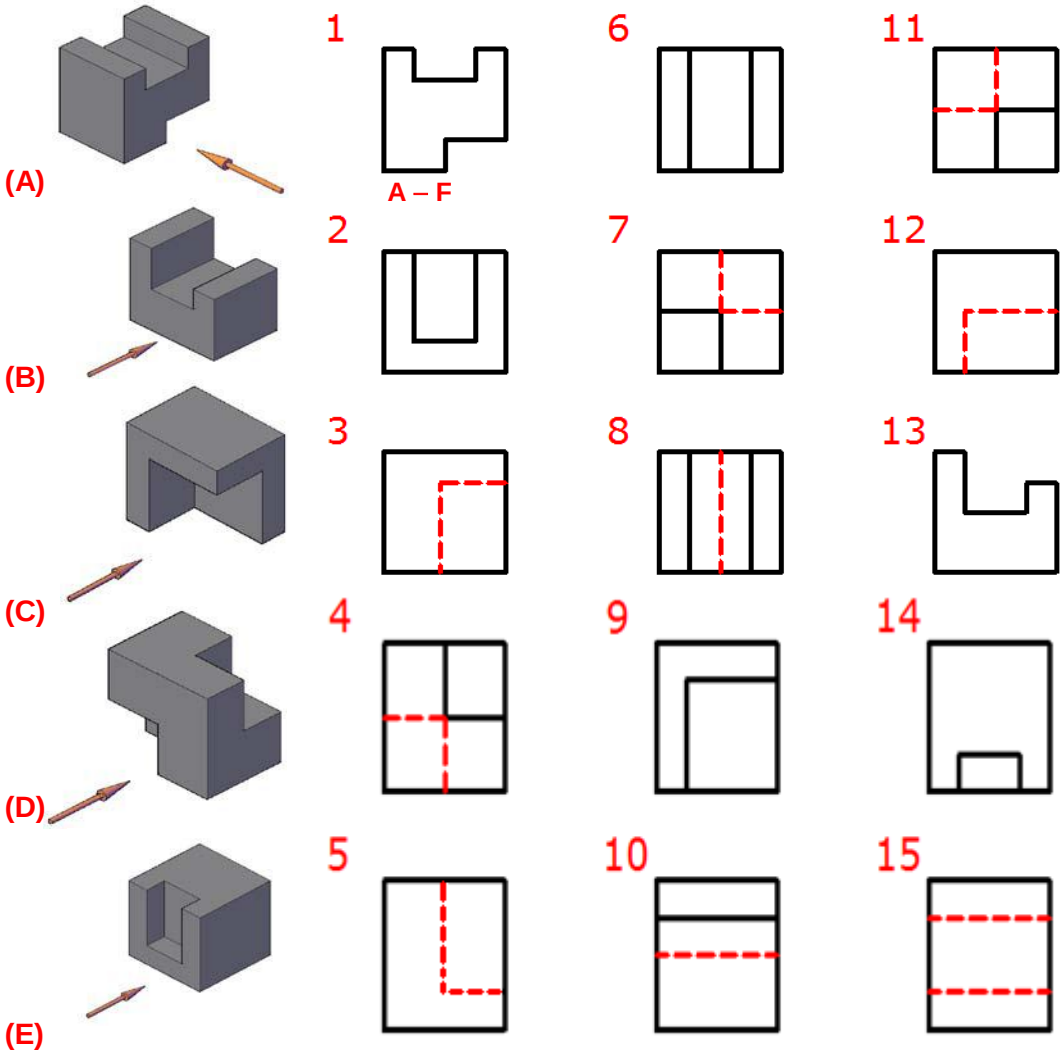


(b) views of the given object

Fig. 6.31 Identification of surfaces

Checkpoint 6.4

Pictorial drawings and views of objects are given in the figure. Match the views and the pictorial drawing by writing the letter representing the pictorial drawing and the letter representing the type of the view below the views. For example, view 1 is the front view of object A. Then, we write A-F below view 1 as shown. This means A stands for object A and F stands for front view. In a similar manner, use LS for left side and T for top view.



2. Missing line problems

Incomplete views of an object are given in Fig.6.32. To complete these views all the missing lines should be added. In order to find the missing lines, projecting lines should be drawn from one view to the other starting from points on all views. If a projecting line drawn between two views does not have corresponding points on both views, then it implies that there is a missing line which coincides on the projecting line or whose end point is on that projecting line.

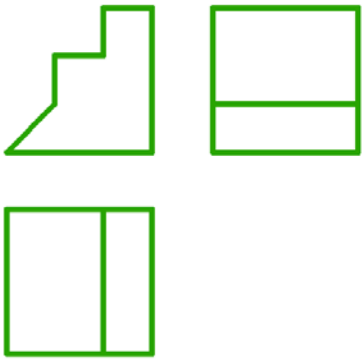
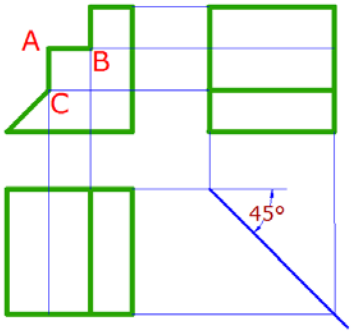
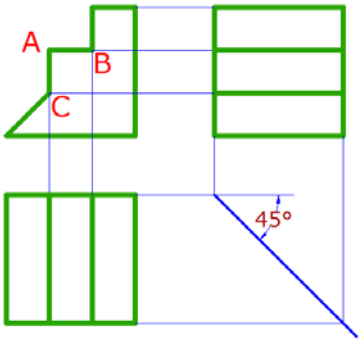


Fig. 6.32 Incomplete view of an object

In Fig.6.33 (a), you can see that the projecting line drawn from A and B to the side view has no corresponding point on the side view. This means there is a missing line on the side view. Likewise, there are no points corresponding to points A and C on the top view. Therefore, there is a missing line on the top view too. Once the locations of the missing lines are identified, the next step is to imagine an object whose views are similar to the given views. To help visualize such an object pictorial freehand sketches may be used. Finally, the missing lines are added as shown in Fig. 6.33 (b).



(a) Drawing the projectors

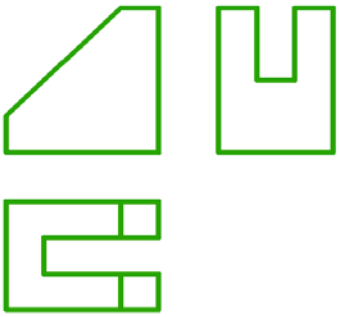


(b) Adding the missing lines

Fig. 6.33 complete projection

Checkpoint 6.5

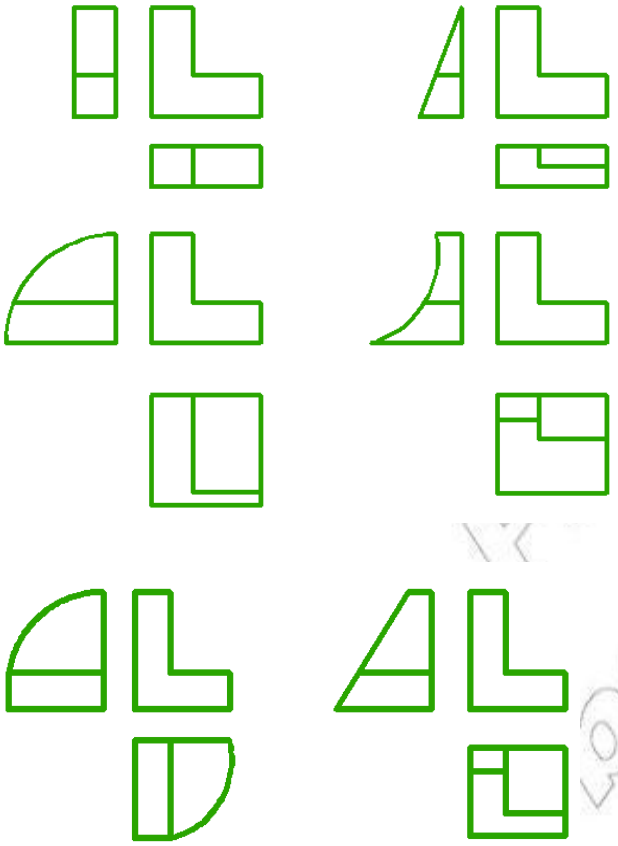
Add the missing lines on the views given in the figure.



3. Possible view problems

In Fig. 6.34(a), a front view is given. Fig.6.34 (b) shows that it is possible to find objects that have similar front view but varying in other views.

(a) Given front view

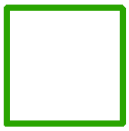


(b) Possible views

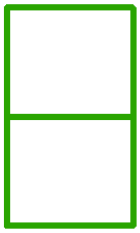
Fig.6.34 Possible view problem

Checkpoint 6.6

Find at least three objects whose top view is as shown in (A). Also find at least three objects whose front view is as shown in (B).



(A)



(B)

4. Missing view or third view problem

If two projections of an object are given, it is possible to find out the third projection. In Fig.6.35 two views of an object are given. In Fig. 6.36 the method of finding the third view with the help of projecting lines is illustrated. In this case, it is necessary to visualize the object from the given views when going over the necessary lines in step II.

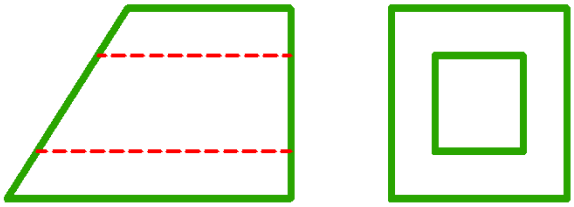
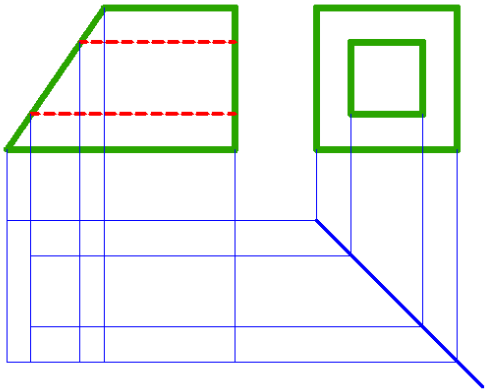
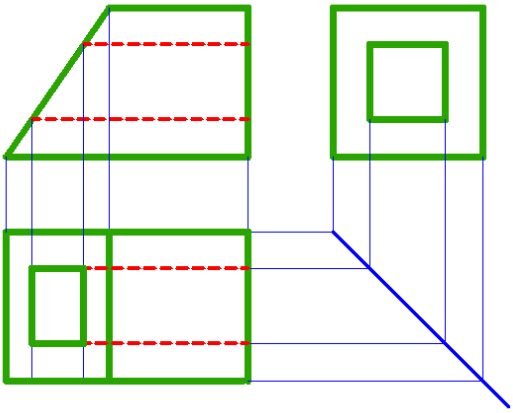


Fig. 6.35 Given view of an object



Step I. Draw the projecting lines from the two given views to the missed view.

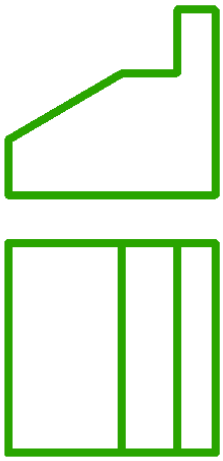


Step II. Complete the missing view by going over the necessary lines.

Fig. 6.36 Method of finding the third view

Checkpoint 6.7

Draw the right side view of the object whose front and top views are as shown in the figure.



UNIT SUMMARY

A pictorial drawing shows an object as it appears to the observer, but not in its true lengths. Such a picture cannot describe the object fully, no matter which direction it is viewed from, because it does not show the exact shapes and sizes of the several parts. In industry, a complete and clear description of the shape and size of an object to be made is necessary. Therefore, a number of views systematically arranged, are used. This system of view is called multi-view projection.

Multi-view drawings are an important part of engineering and technical graphics. To create multi-view drawings takes a high degree of visualization skill and much practice. Multi-view drawings are created by closely following orthographic projection techniques and standards. The rules of orthographic projection are listed here for your reference.

Rule 1: Every point or feature in one view must be aligned on a parallel projector in any adjacent view.

Rule 2: Distances between any two points of a feature in related views must be equal.

Rule 3: Features are true length or true size when the lines of sight are perpendicular to the feature.

Rule 4: Features are foreshortened when the lines of sight are not perpendicular to the feature.

Rule 5: Areas that are the same feature will always be similar in configuration from one view to the next, unless viewed as an edge.

Rule 6: Parallel features will always appear parallel in all views.

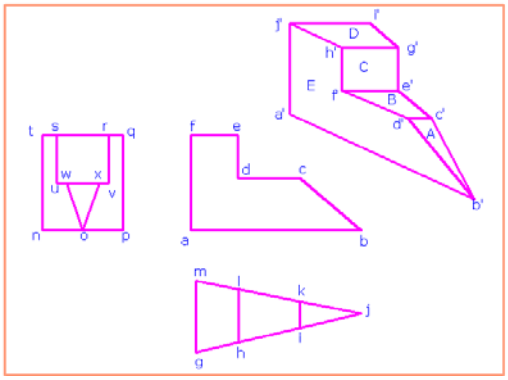
Rule 7: Surfaces that are parallel to the lines of sight will appear an edge and be represented as a line.

Exercise I:

1. Define orthographic projection.
2. How is orthographic projection different from perspective projection? Use a sketch to highlight the differences.
3. Define multi-view drawings and make a simple sketch of an object using multi-views.
4. Define frontal, horizontal, and profile planes.
5. List the six principal views.
6. Define fold lines.
7. List the space dimensions found on a front view, top view and profile view.
8. Define a normal surface.
9. Define an inclined surface.
10. Define an oblique surface.
11. List the 8 rules of orthographic projection.

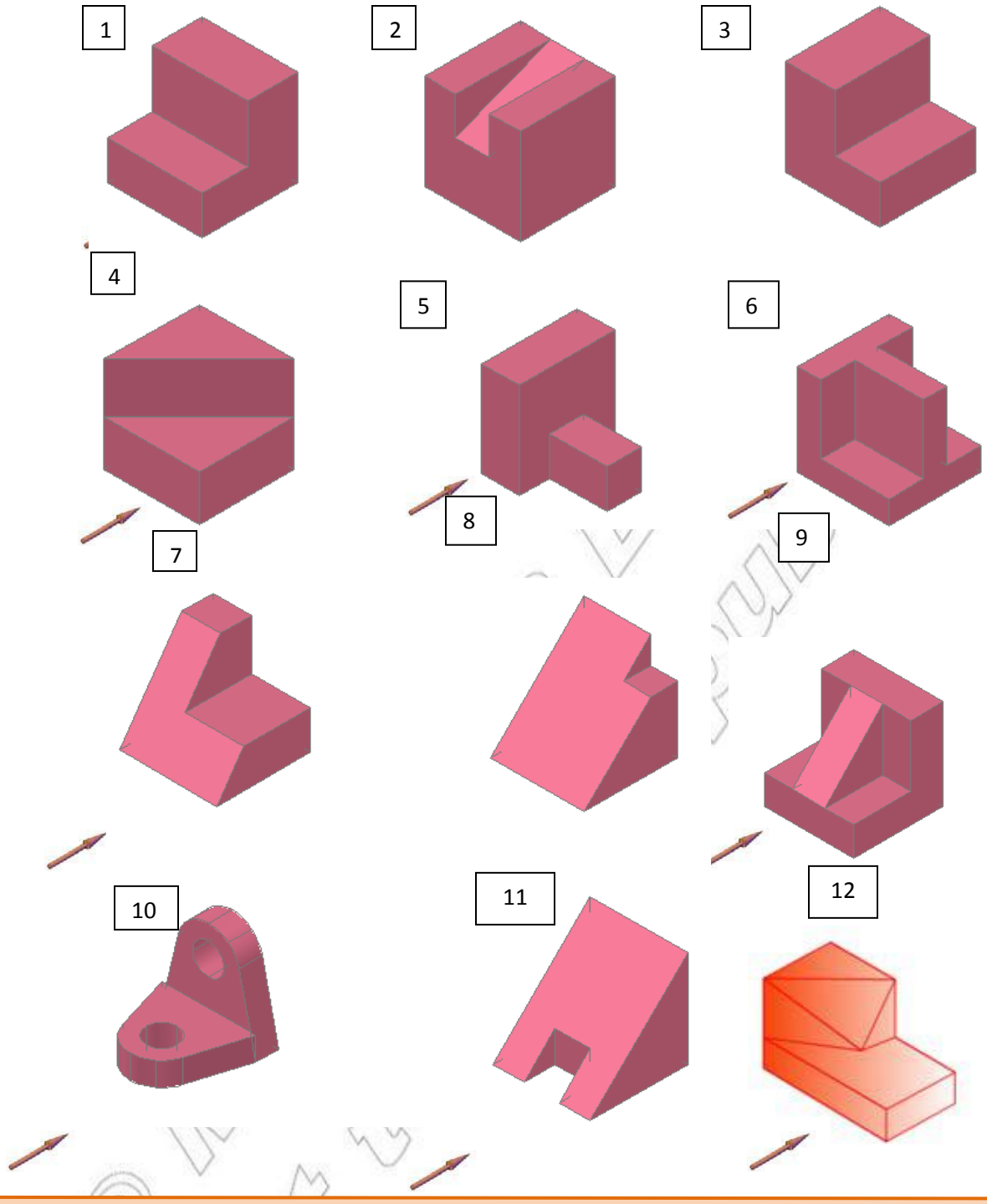
Exercise II

Interpret simple orthographic drawings by relating them to the isometric views of the objects.



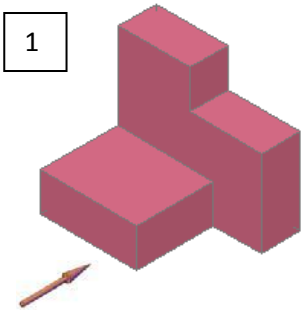
1. Note line b'-d' on surface A of the oblique drawing. Which of the following statements is correct?
   a) line o-w in the right side view shows line b'-d' in true length
   b) line i-j in the top view shows line b'-d' in true length
   c) line b-c in the front view shows line b'-d' in true length
   d) none of the three views shows line b'-d' in true length
2. Note line f'-h' on surface C of the oblique drawing. Which view(s) will show f'-h' in true length?
   a. front only c. right side only
   b. top and front d. front and right side
3. Which line in the top view represents the same line as line v-x in the right side view?
   a. i-k b. l-m c. k-l d. h-i
4. Which of the following surfaces will be shown in true length and shape in at least one of the three views?
   a. A and C c. B, C, and D
   b. C and E d. A, B, and E

Exercise III: Draw the three necessary views of the objects whose pictorial drawings are given in Exercise III, and IV. Use 1:1 scale and 1st angle projection .



Exercise IV

1



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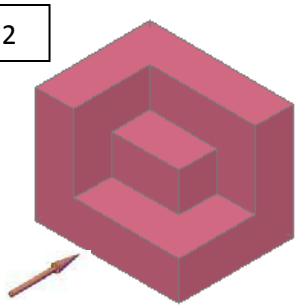

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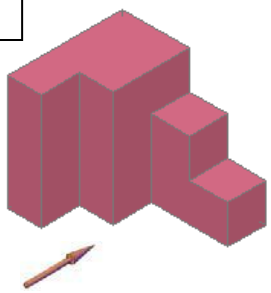

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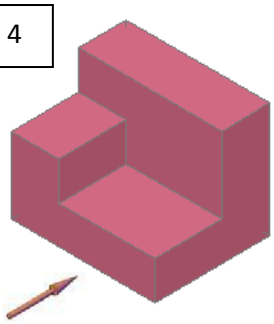

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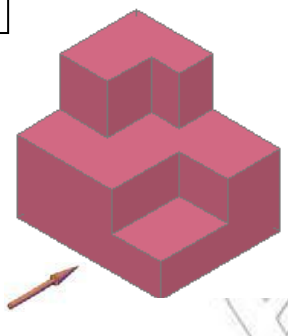

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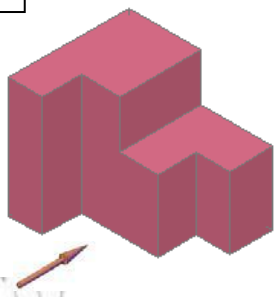

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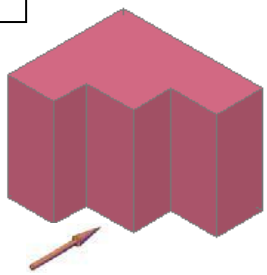

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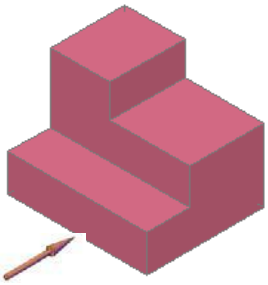

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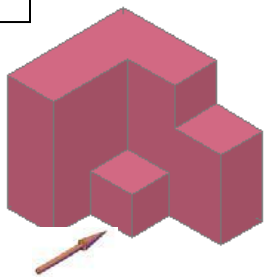

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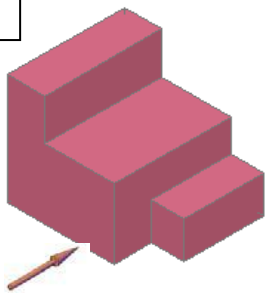

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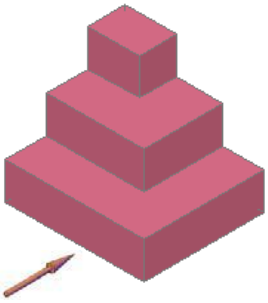

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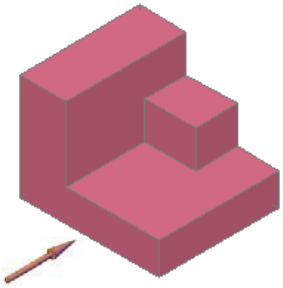
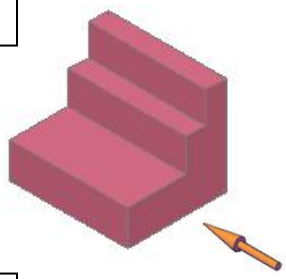


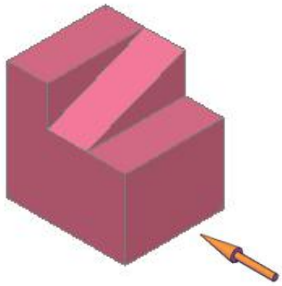
Exercise V: Missing line and missing view problems

Pictorial drawings of twelve objects are shown in Exercise V. Incomplete views of these objects are given in Exercise VI and VII. These views are randomly arranged. Match these views on your drawing paper to the given objects by writing the number of the object in the circles and complete the views by adding the missing lines or by drawing the third view.

1



2



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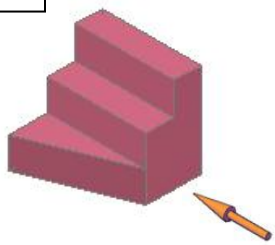

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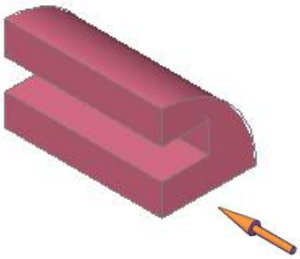

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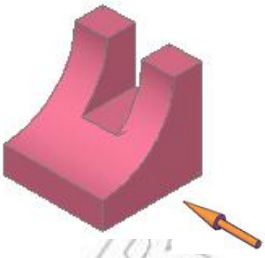

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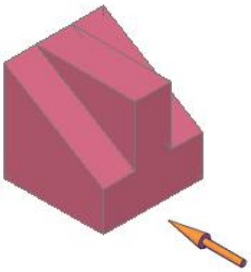

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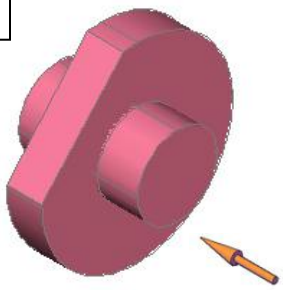

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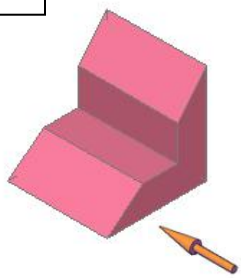

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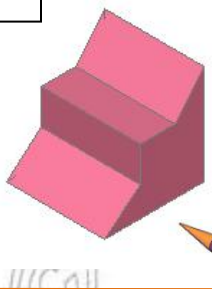

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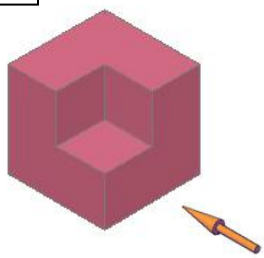

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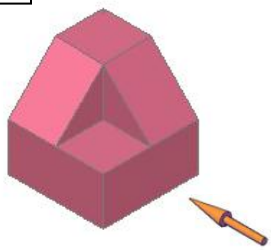
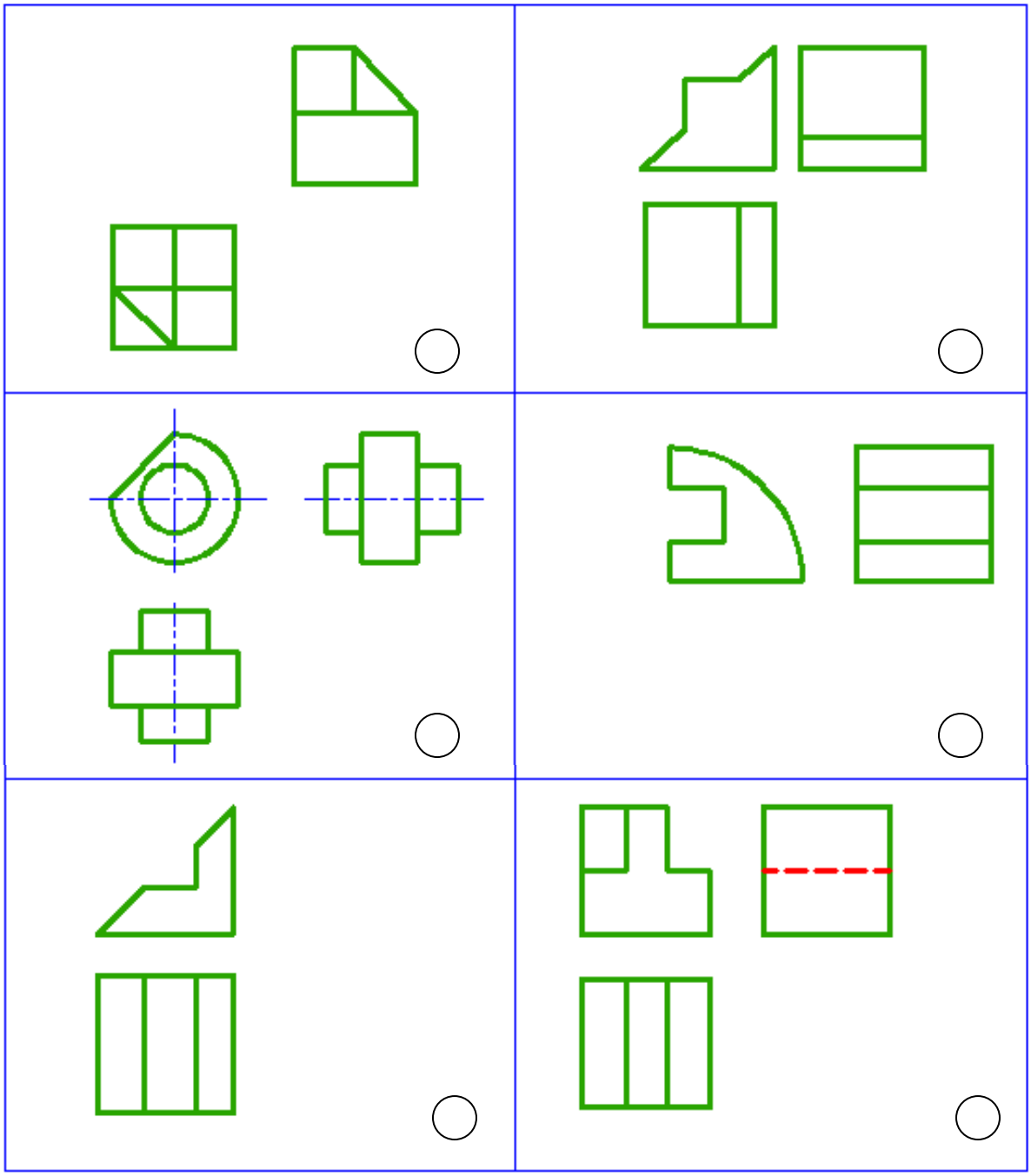
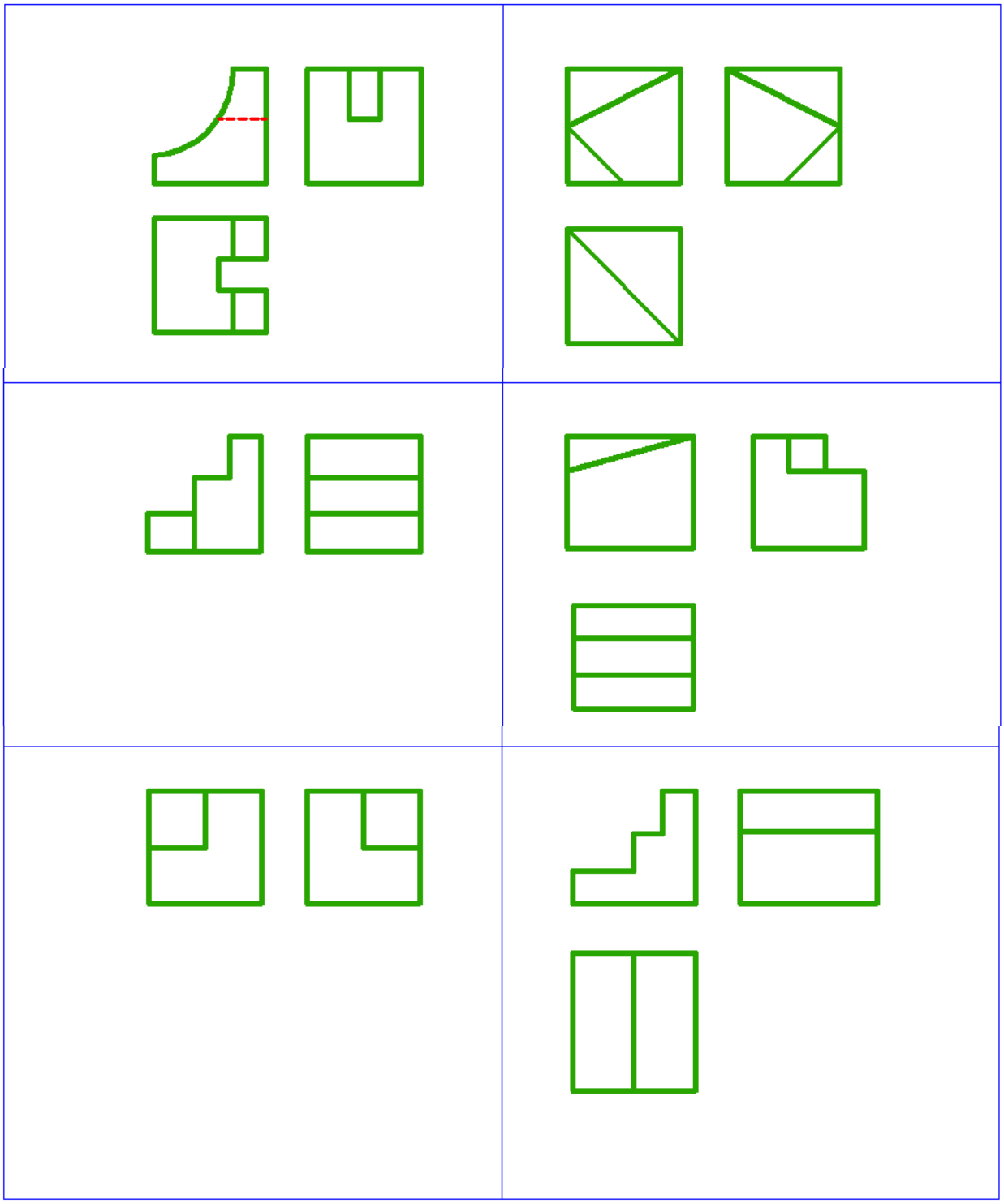


Exercise VI: Given incomplete views

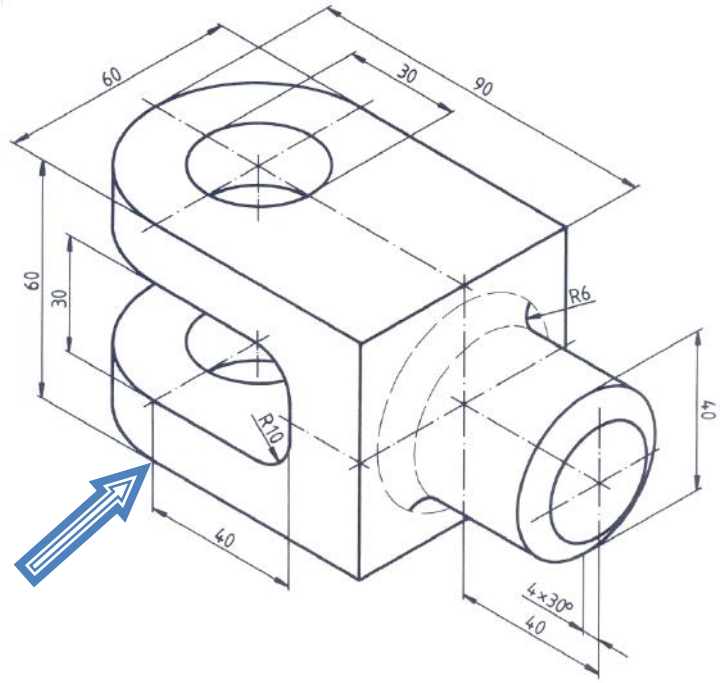


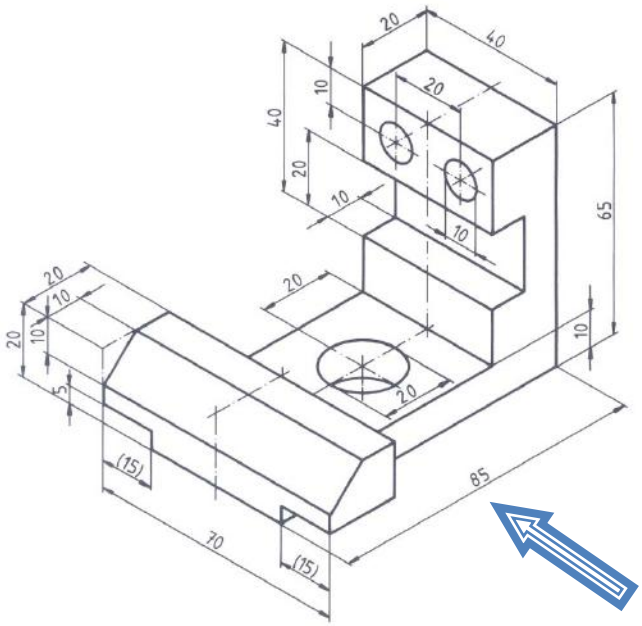
Exercise VII: Given incomplete views

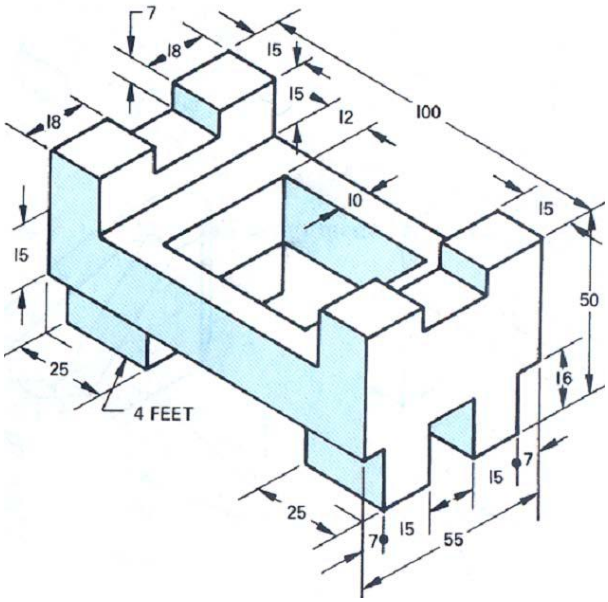


Project

Using the first angle projection system, draw the three principal views of the objects whose pictorial drawings are given below. (The arrow shows the front direction of the object)






7
18
15
15
12
100
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15
50
16
25
4 FEET
7
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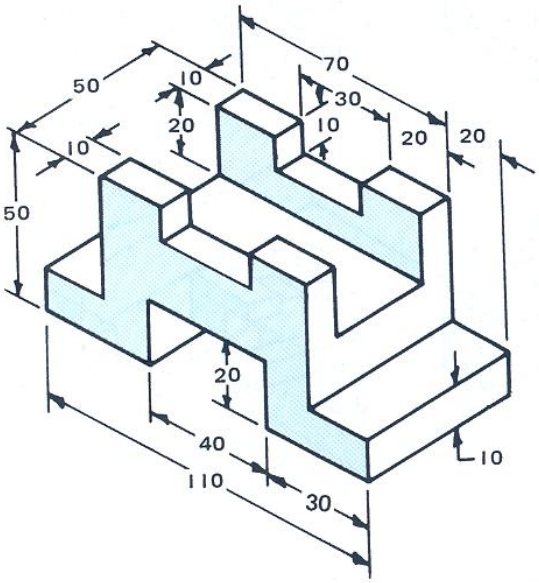
7
15
55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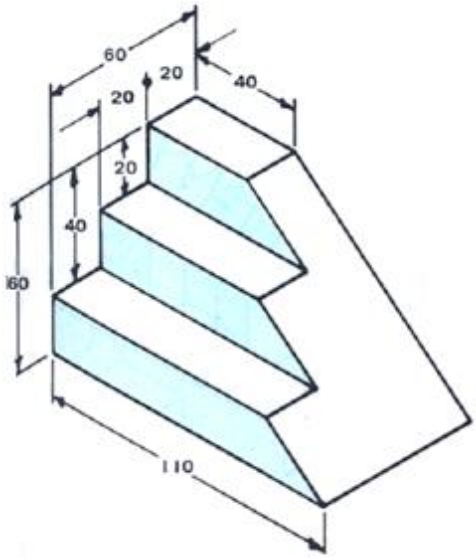
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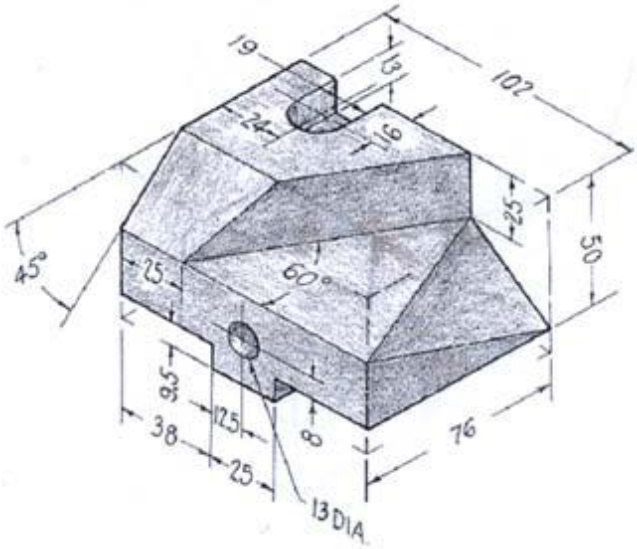
19
13
102
24
16
25
50
45°
25
60°
9.5
12.5
38
25
8
76
13 DIA