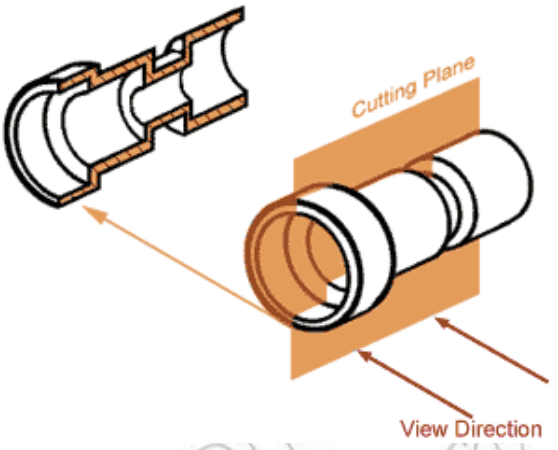
UNIT 3

SECTIONAL VIEW



Learning Competencies:

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

- **Define the concept and the use of sectional views;**
- **Describe and select the location of cutting plane to create sectional view;**
- **Identify and make different types of section lining;**
- **Visualize the sectional view of an object;**
- **Identify the types of sectional views;**
- **Compare and contrast the advantage of all types of sectional views;**
- **Select the appropriate type of section to the given object;**
- **Perform the sectional view of an object with preferable type of section.**

3.1 Introduction

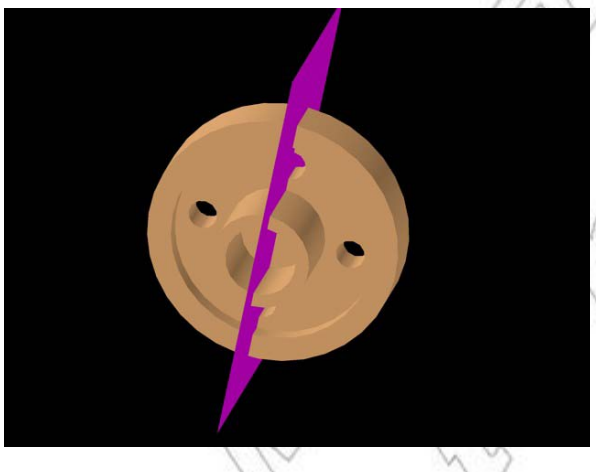
- Have you ever cut an orange with a knife? Did you observed the internal part of it? What are the reasons we need to see the interior part of an object?

The basic method of representing parts for designs by views, or projections, has been explained in grade 11 (chapter 6) . However, we are frequently confronted with the necessity of showing more or less complicated interiors of parts that cannot be shown clearly by means of hidden lines. We accomplish this by slicing through the part as one would cut through an apple or a melon. In such cases, imaginary cutting planes are made to pass through objects exposing their interior features. The revealed view of the object is then drawn with the conventions of orthographic projection and it is called ***sectional view***.

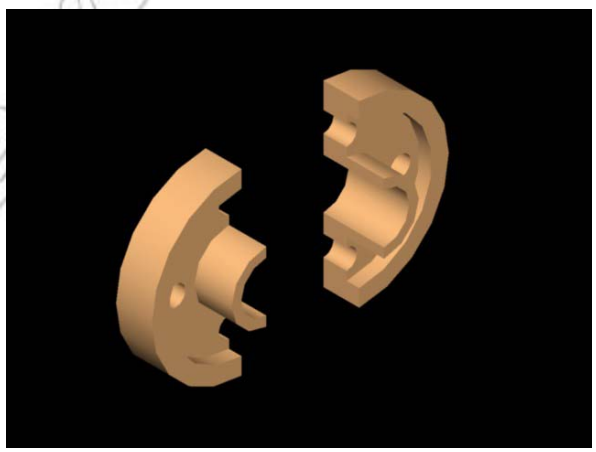
When a cutting plane reveals the object lengthwise, the section obtained is known as longitudinal section; and when it is done crosswise it is called cross-section. The surfaces of the object which the imaginary cutting plane touches will be represented by hatches. The hatches may vary according to the material made of.

The figure below shows how a sectional view is made and the difference between the orthographic and the sectional view.

If you observe in Fig.3.2 **c** it is hard to visualize the interior details of the object due to the hidden lines. Whereas on the other hand which is the sectional view (Fig.3.2 **a**) provides a visual clarity to the object.



(Before revealing)



(After revealing)

Fig. 3.1 Section in a 3d view

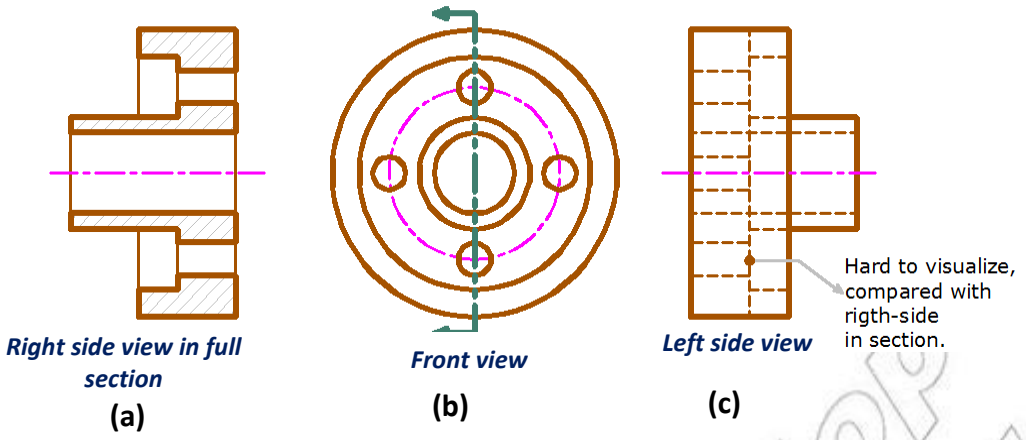
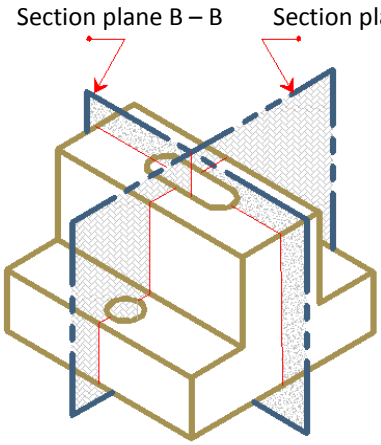


Fig .3.2 Sectional view and its relation with orthographic projection

3.2 Cutting Plane and Section Lining

Activity 3.1

1. Can you imagine a cube having a hole in the center? Sketch it.
2. Imagine the cube cut at the middle like that of an orange. Try to sketch the revealed cube by ignoring one of its part.



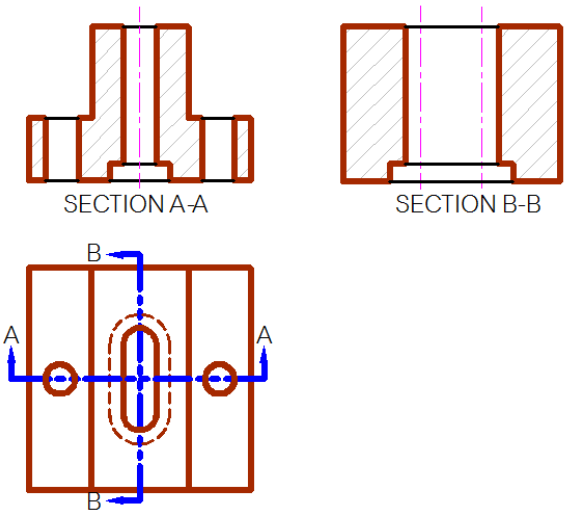


Fig. 3.3 Cutting planes and sections

Cutting Plane: The cutting plane is indicated in a view adjacent to the sectional view, Fig 3.3. In this view, the cutting plane appears edgewise or as a line, called the cutting plane line. A cutting plane line is represented either by a line pattern composed of alternate long dashes and a pair of short dashes or equal short dashes. And such lines should be made with a well sharpened medium thick pencil like an H or

a 2H. Cutting plane lines are drawn having a heavy weight with arrow heads which indicates the viewing direction. At the end of the arrows upper case letters may be attached in order to give reference to the section made. This is especially necessary when we use more than one cutting planes.

Fig. 3.4 shows symbolic line types that can be used to represent a cutting plane line.

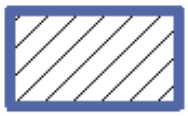
a) Straight cutting plane line cutting plane is short)

b) Straight cutting plane line (used when cutting plane is long)

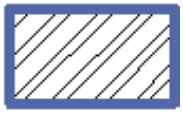
c) Offset cutting plane

Fig. 3.4 Cutting plane lines

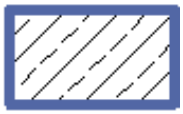
Section Lining: section lines are light thin lines, usually drawn as a 45 degree inclined line in case of general purpose. These lines are represented on the surface of the object which the cutting plane have direct contact. The crosshatched surfaces of the object were represented as a hidden line but now as a visible surface. Symbolic section lining may be used in assembly drawings in cases where it is desirable to distinguish the different materials used. Section lining symbols for representation of some commonly used engineering materials are shown in the figure below.



Cast or malleable iron and general use for all materials



Steel

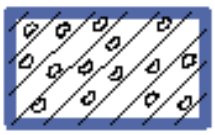


Bronze, Brass, Copper, and compositions

White metal, Zinc, Lead, Babbitt, Alloys

Magnesium, Aluminum and Aluminum alloys

Cork, felt, fabric, leather, and fiber



Sound insulation

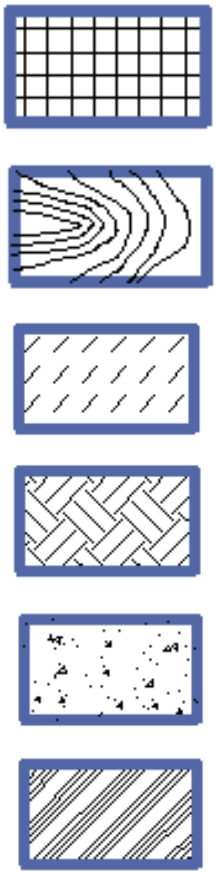


Fig. 3.5 Symbols of materials in section

The correct and incorrect practices of section linings are represented in the figure below.

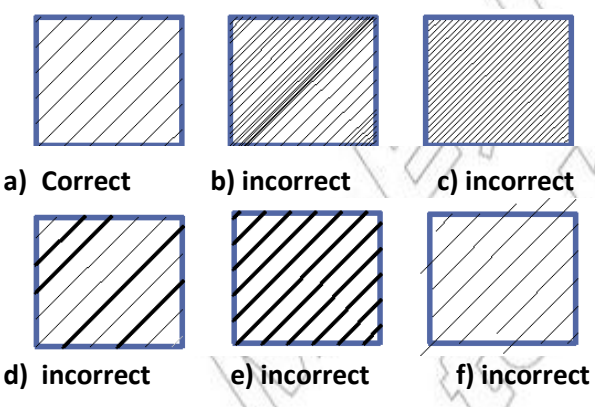


Fig. 3.6 Correct and incorrect practices of section linings

The direction of section lines are illustrated in the figure below.

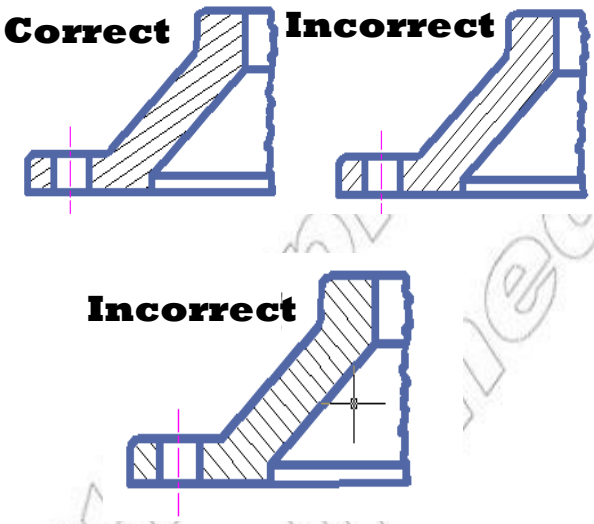
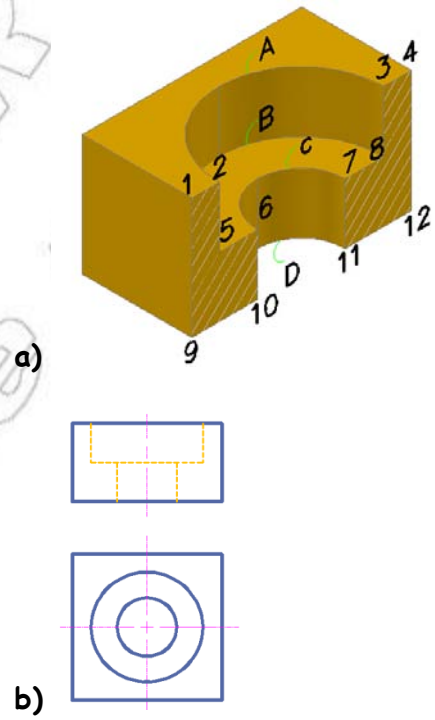
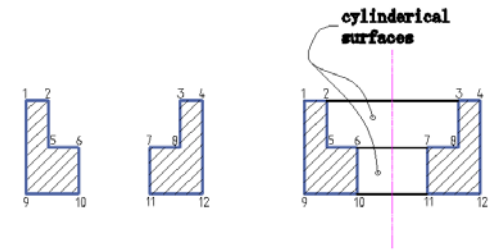


Fig. 3.7 Direction of section lines

3.3 Visualizing a Sectional View





c) d)

Fig 3.8 Visualizing a sectional view

Two views of an object to be sectioned, having a drilled and counter bored hole, are shown in Fig.3.8. The cutting plane is assumed along the horizontal center line in the top view, and the front half of the object (lower half of the top view) is imagined removed. A pictorial drawing of the remaining back half is shown at (a). The two cut surfaces produced by the cutting plane are 1-2-5-6-10-9 and 3-4-12-11-7-8. However, the corresponding section at (C) is incomplete because certain visible lines are missing.

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, and 10-11. These lines may also be accounted for in other ways. 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 in the section as line 5-8. Also, the semi cylindrical surfaces for the back half of the counter bore and of the drilled hole will appear as rectangles in the section at 2-3-8-5 and 6-7-11-10.

3.4 Types of Sectional View

Depending on the way and the required details to be shown, sectional views can be classified as follows.

(a) Full sections
(b) Half sections
(c) Offset sections
(d) Broken-out or partial sections
(e) Revolved sections, and
(f) Removed section

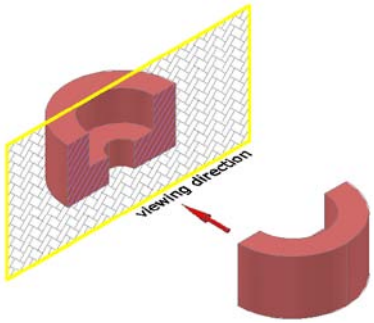
3.4.1 Full Sections

The sectional view obtained by passing the cutting plane fully through the object is called a *full section*. The cutting plane appears as a straight line and will never bend. This type of sectional view is mostly used when the expected details to be shown appear:

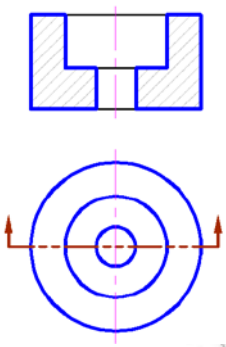
1. non-symmetrically
2. aligned with a certain axis
3. centrally without other details

In general, the following points should be noted when making full sectional view of an object:

- In making the sectioned view, one half of the object is imagined to be removed
- Invisible lines behind the revealed surfaces are usually omitted
- Visible lines behind the section should be drawn.
- Only the surfaces actually cut by the section plane are crosshatched.



a) Pictorial representation

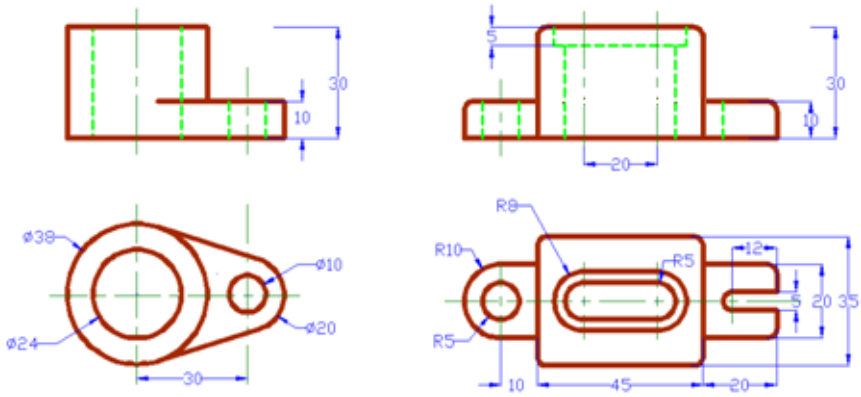


b) Orthographic views

Fig .3.9 Full section

Checkpoint 3.1

The front and top views of the objects are given, redraw them with the same scale and show the front views in full section.



3.4.2 Half Sections

Imagine when one fourth of an orange is revealed and sketch its appearance and show to neighbor friend.

If the cutting plane passes halfway through the object, the result is a *half section*. A half section has the advantage of exposing the interior of one half of the object and retaining the exterior of the other half. Its usefulness is, therefore, largely limited to symmetrical objects. It is not widely used in detail drawings (single parts) because of this limitation of symmetry and also because of difficulties in dimensioning internal shapes that are shown in part in the sectioned half.

In general, the following rules should be noted in making a half-sectioned object:

- One half of the sectioned view should be in section, while the other half remains as an external view.
- Hidden lines will normally be omitted from both sides of the view unless necessary for clearness of interpretation of surfaces.
- Hidden lines may be shown on the unsectioned half, if required for dimensioning purpose.
- The line separating the sectioned half from the external half should be a center line.

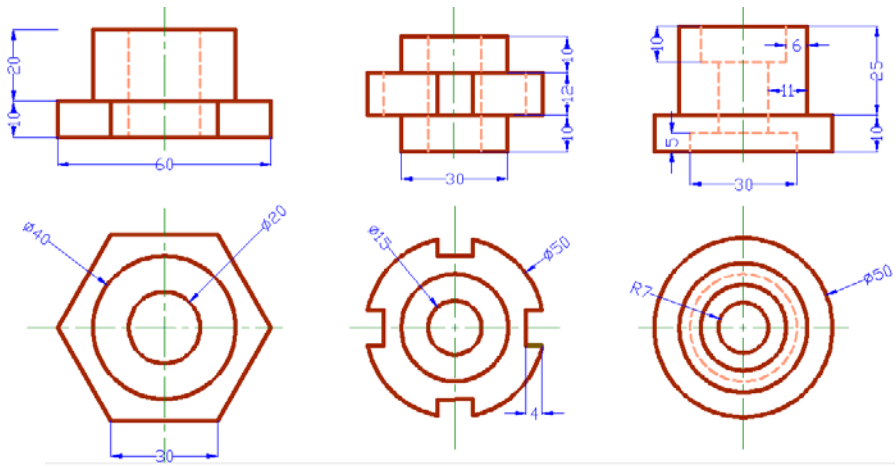
a) Pictorial representation *b) One- quarter of the object being removed* *c) Orthographic views*

Fig. 3.10 Half section

Checkpoint 3.2

Front and Top Views of three different objects are given

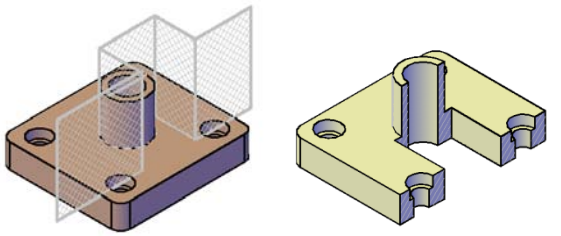
- **Redraw them to full scale**
- **Project the half section on the front view**



3.4.3 Offset Sections

1. Try to imagine a cube revealed in a path bending more than two parts.
2. Sketch the appearance and show to your teacher.

In sectioning through irregular objects, it is often desirable to show several features that do not lie in a straight line, by "*offsetting*" or "*bending*" the cutting plane. Such section is called an *offset section*. The cutting plane bends orthogonally or uses 90° to bend. The sectional view is drawn as if the interior details are kept aligned in a straight line position. This means we do not show the edges made by the bending of the cutting plane. The figure below illustrates the above mentioned concepts.



a) Pictorial Representation *b) Interior features being exposed*

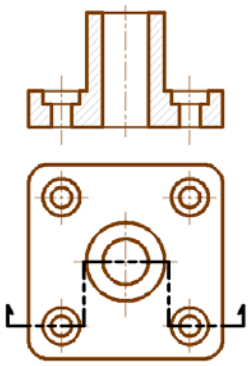
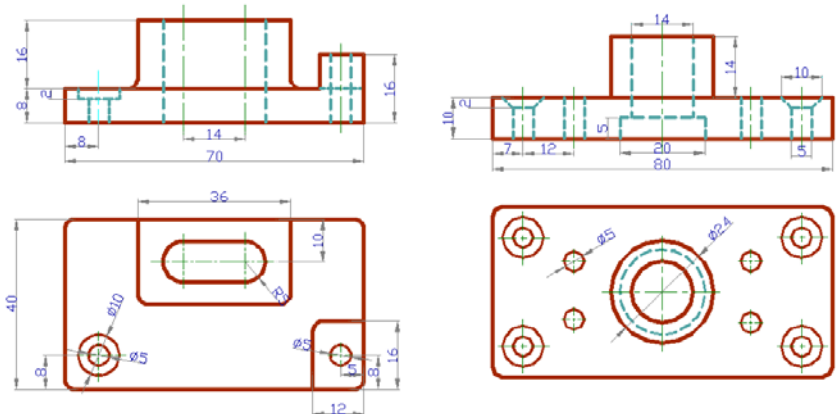


Fig. 3.11 Offset section

Checkpoint 3.3

Redraw the given front and top views on your drawing paper to full scale and choose an appropriate offset cutting plane line on the top view in order to reveal all important interior details in section on the front views.



In general, the following points should be carefully observed in offset sections:

- The location of the cutting plane must be shown by the proper symbolic line in the adjacent view.
- Arrows should be placed at the ends of the cutting plane line showing the direction in which the view is made.
- The edges made by the bends of the cutting plane are ignored.

3.4.4 Broken-out (Partial) Sections

Activity 3.2

1. What do you understand from the word broken-out?
2. How do you expect it to be applied in sectional view?

When it is necessary to show only a partial section of a view to expose interior details limited by a break line, is known as *broken-out section*.

Such sections may be used to show only a portion of the interior of an object without losing important exterior features. The object is assumed to be cut by an irregular cutting plane around the portion of the object to be displayed and the front part is removed by breaking it away. The breaking away is represented by an irregular freehand line known as short break line as shown in the figure below.

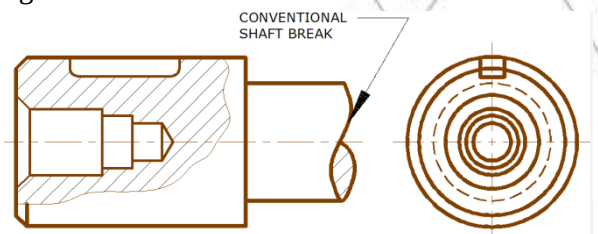


Fig. 3.12 Broken out section

3.4.5 Revolved Sections

1. What is the literal meaning of revolve?
2. How do you expect a revolved section to appear?

The shape of a bar, arm, spoke, or other elongated symmetrical features may be shown in the longitudinal view by means of a *revolved section* (Fig.3.13). The cutting plane in a revolved section is passed perpendicular to the axis of the elongated symmetrical feature and then revolved 90 into the plane of the drawing. It is sometimes important to provide an open space for the section by making a break in the normal view of the object as shown in (Fig 3.13 a). (Fig. 3.13 b) and (Fig. 3.13 c) illustrates some examples of revolved sections.

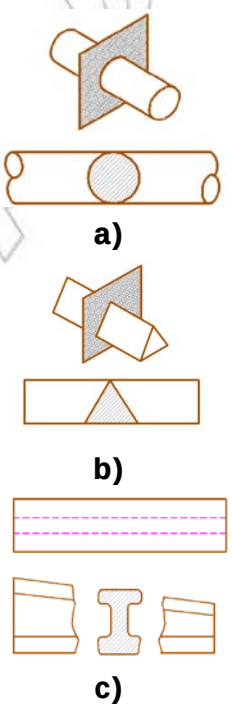
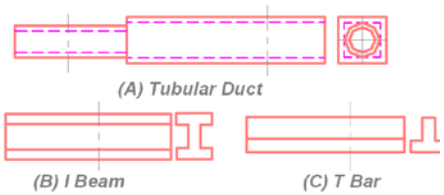


Fig 3.13 Revolved sections showing (a) Solid cylinder, (b) solid triangular prism, and (c) conventional break to show section

Checkpoint 3.4

Front and side views of different elongated objects are as shown in the figure below. Trace the views on your drawing paper to full scale and show the cross-section of each objet at the indicated positions of the cutting plane lines using appropriate revolved section.



3.4.6 Removed Section

Can you relate removing and sectioning with an example?

Removed sections are similar to revolved sections but are not drawn within the view containing the cutting plane. It is drawn out side the normal view representation. Usually, it is represented by extending the cutting plane line adjacent to the cutting plane. In this case, a center line drawn across the object is used as an axis of rotation to denote where the section is taken. The corresp-onding removed section is then projected along the axis extending from the desired cut position. In here, it is unnecessary to show a cutting plane or to label the sectioned view.

Fig.3.14 shows removed cross-section of a lifting hook.

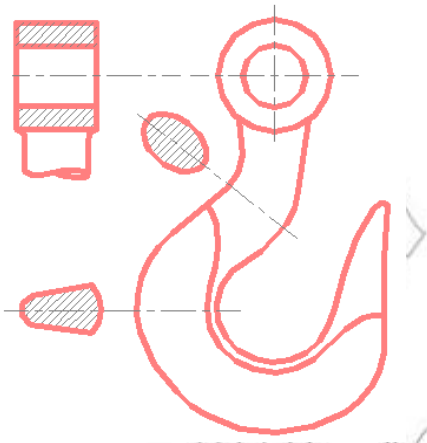


Fig. 3.14 Removed sections of a hook

Generally, removed or detail sections are more useful than revolved sections because of two basic reasons:

- To prevent a principal view of an object of varying cross-section from being cluttered with numerous revolved sections, and
- To enable a removed cross-section to be drawn with an enlarged scale so that additional details can be emphasized and allow adequate space for dimensioning.

In practical drawings, a number of detail sections may be drawn outside the regular view of a complex object. In this case, there should be some means of identifying the position of the cross-section represented. This is usually accomplished by showing the cutting plane on the principal view and labeling both the plane and the resulting view as shown in fig 3.15.

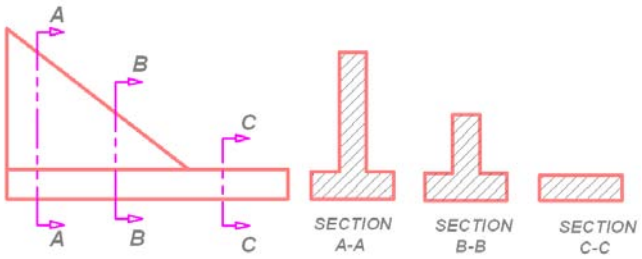


Fig. 3.15 Removed cross section of a shaft

3.5 Other Sectional View Representation

As sectional view is very essential to full describe a design, other sectional view representation also has a part to solve a problem.

3.5.1 Aligned Section

In order to include in a section certain angled elements, the cutting plane may be bent so as to pass through those features. The plane and feature are then imagined to be revolved into the original plane. Fig. 3,16 (b) and (c), shows how the section view appears when the cutting plane and features of the object are rotated into a plane perpendicular to the line of sight.

The angle of revolution or angle through which the cutting plane is bent is always less than 90. To avoid misunderstanding, an aligned section view should never appear foreshortened as in Fi.3.16(a). The location of the cutting plane in aligned section should be shown on the adjacent normal view of the object (Fig. 3.16 (c)).

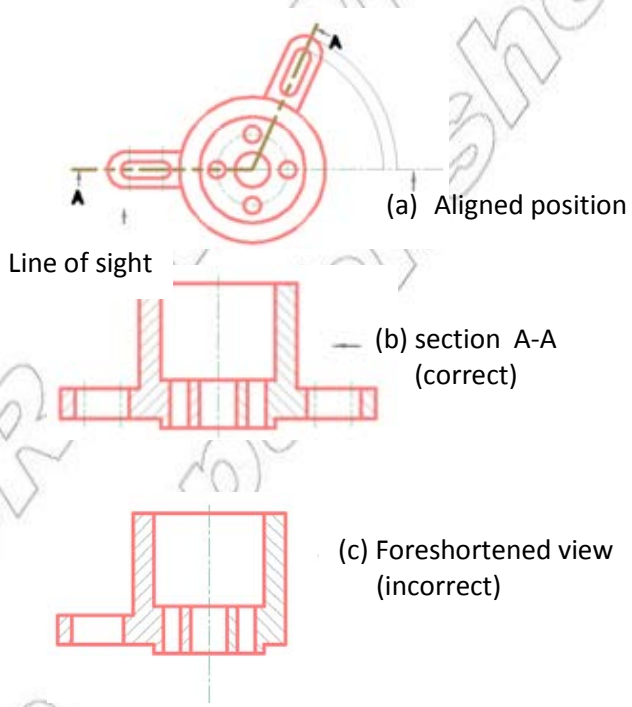
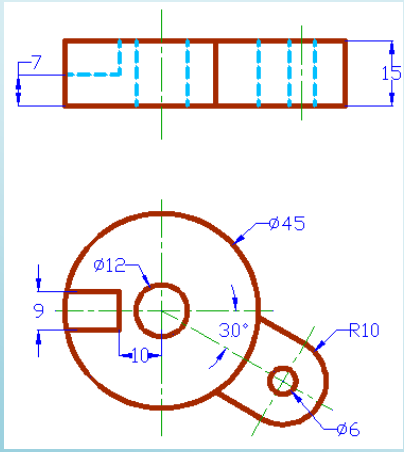
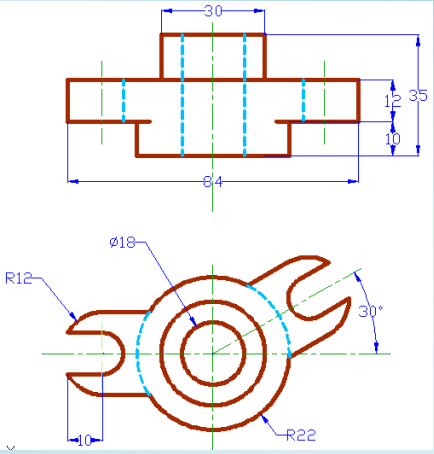


Fig. 3.16 Aligned Section

Checkpoint 3.5

Front and top views of two objects are as shown in the figure. Redraw the views on your drawing paper to full scale and make an appropriate aligned section of the front views.





Key terms

- ***Cross hatching***: *i*s a series of thin lines drawn 45° to horizontal. It is used to show the features cut by the cutting plane. Cross hatching makes features stand out on the drawing.
- ***Cutting plane:*** is the surface that is created when a cut is made through a component to reveal the internal features. It can also be called a section plane.
- ***Off-cut***: is the term used to describe the unused portion of material from which an object has been cut.
- ***Part section***: a method of showing internal detail for one small section of a drawing only.

3.5.2 Auxiliary Section

1. How do you think auxiliary and section relate?
2. Form a group and discuss with your friends then present it to the class by representing a group leader.

A sectional view that appears on a plane inclined to any of the principal projection planes is called an *auxiliary section*. The auxiliary section is projected into a position on the drawing so that the line of sight for the view is perpendicular to the cutting plane line. It is used to show the shape of a surface cut by a cutting plane or cross-sectional shape of an arm or a rib inclined to the regular planes. An auxiliary view in section is drawn by the usual methods of auxiliary projections discussed in chapter two. When a

cutting plane cuts an object, as shown in Fig. 3.17, arrows at the ends of the cutting plane line indicates the direction in which the cut surface is viewed.

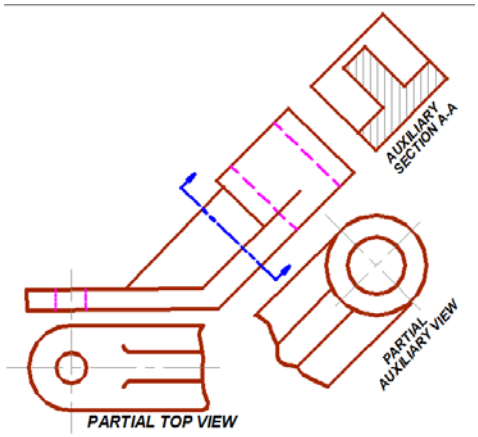


Fig. 3.17 Auxiliary section

3.6 Conventional Representations in Sectioning

Have you ever seen a machine drawing?
Have you seen a machine assembled and functioning?
List the type of machines you ever saw. Imagine the sectional view as it is assembled.

Sometimes, the level of confusion in some sectional view representation can be reduced by violating certain rules of orthographic projection. For example, nothing could be gained by showing the solid interior of some parts like shaft, bars, bolts, nuts and screws, It is therefore a customary practice to assume that such parts are not cut by a cutting plane that may pass through the parts. In this practice, not only the considerable time and effort required to crosshatch these areas is saved but also the representation of an object or assembly will be more clear and easy to understand. Fig.3.18 illustrates conventional representation of these parts in section.

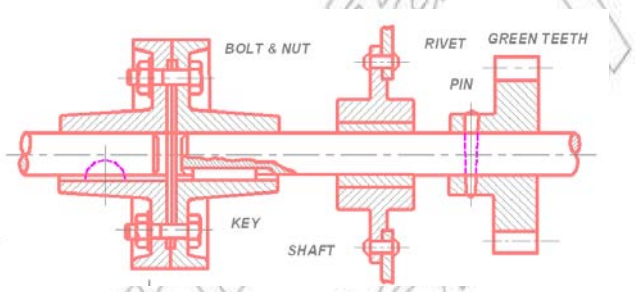
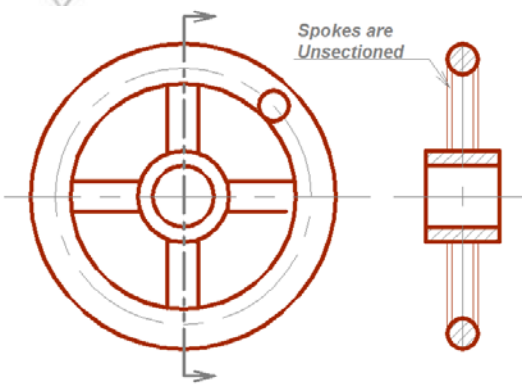
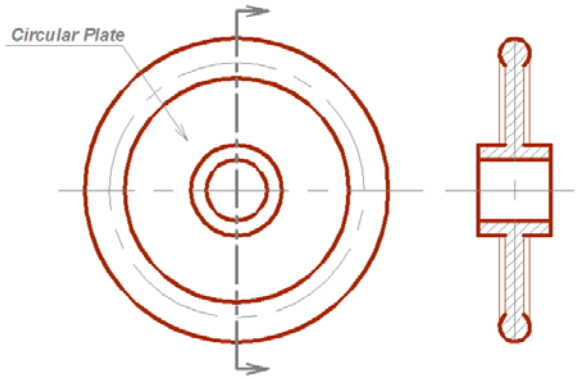


Fig .3.18 Solid shafts, bolts, screws, nuts, etc in section

Some solid features of certain parts like spokes of a wheel are not sectioned, even though the cutting plane passes through them. Such representation is used to distinguish a wheel with spokes from a wheel with thin plate or web. Fig. 3.19 illustrates the general practice in sectional representation of a wheel with spokes and with plate.



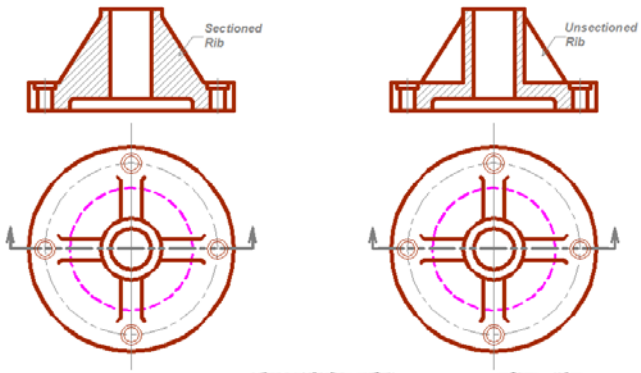
(a) Wheel with spokes



(b) Wheel with spokes

Fig. 3.19 Wheel with spokes and wheel with plate

When the cutting plane passes through the center of a rib length, web, spoke, or other relatively thin element, the section lining is omitted to avoid a false impression of thickness and solidarity (Fig.3.20). However, if the cutting plane passes crosswise through those thin elements, the features are crosshatched as usual.

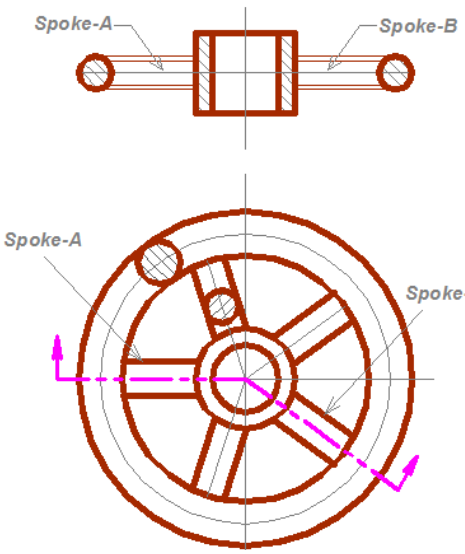


(a) Incorrect Practice *(B) Correct Practice*

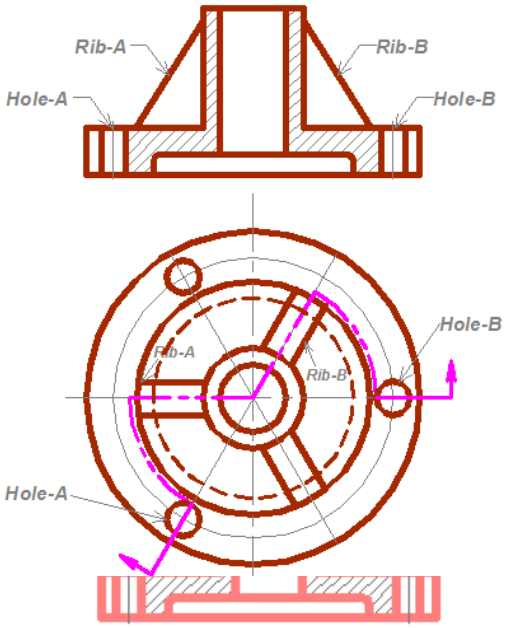
Fig. 3.20 Ribs in section

When there are an odd number of holes, ribs or spokes, which are symmetrically arranged around a cylindrical object, conventional revolutions are used to make section views clear and avoid confusion in interpretation.

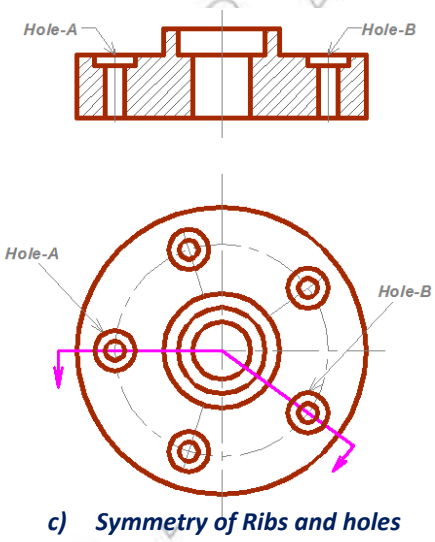
These features may not project orthographically to the section view, but the convention allows for this practice and it is accepted as standard. Therefore, these parts are assumed to be rotated until aligned with the section plane axis as illustrated in Fig. 3.21. It is usually used for both sectioned and unsectioned view representation of objects with odd numbered features.



a) Symmetry of spokes of wheel



b) Symmetry of Holes



c) Symmetry of Ribs and holes

Fig .3.21 Symmetry of spokes of wheel, ribs and holes

Unit summary

Interior features of an object can be described with the use of hidden lines. This can be become confusing however. The use of sectional views simplifies the representation of internal features. In a sectional view we imagine the object is cut by a plane to reveal the interior features.

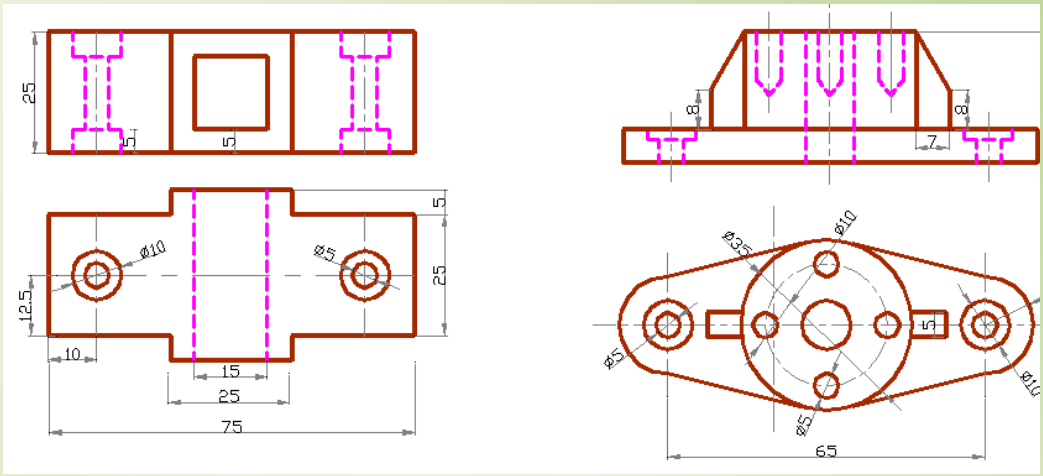
Longitudinal sections cut the object lengthwise. Cross section cuts the object crosswise. A full section cuts the object in half. Section lines represent where the surface was cut. The cutting plane must also be described in another view. A half section cuts the object in a quarter. A half sectional view shows the interior and exterior of the object.

The cutting plane can be offset to show desired features. A broken section (Partial section) can also be used to give greater description of an object.

Revolved and removed sections are used to eliminate the need of a separate view. Line technique is important: contrast, spacing, inclination.

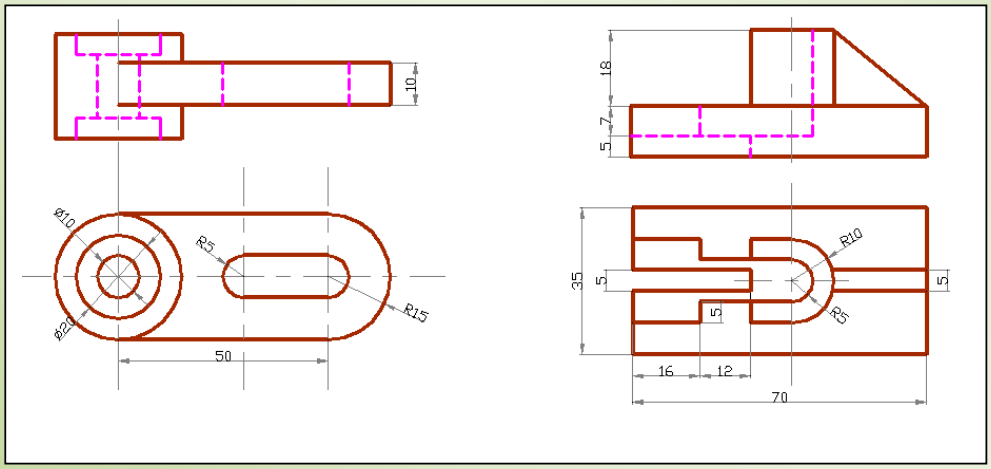
Exercise

1. *For the principal views shown in figure exercise 3.1 draw an appropriate full section of the front views.*



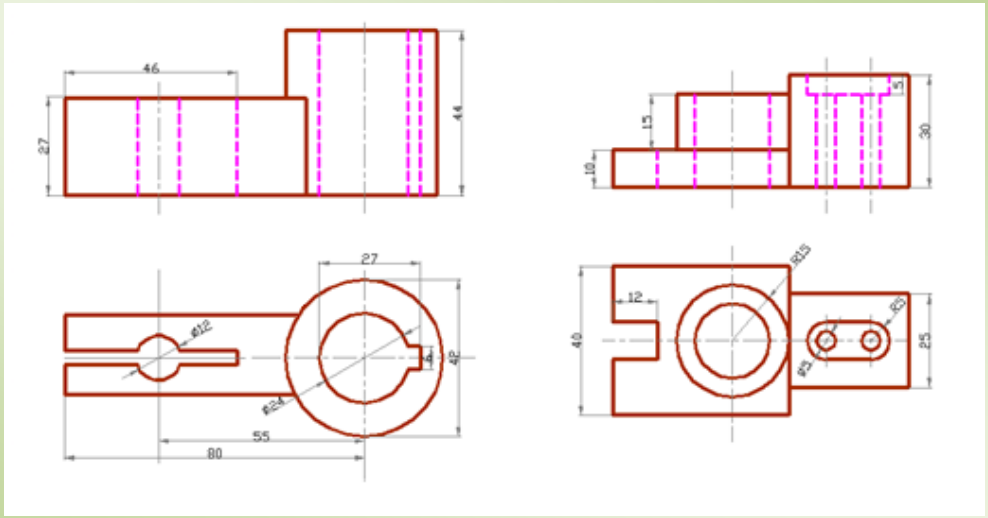
a)

b)



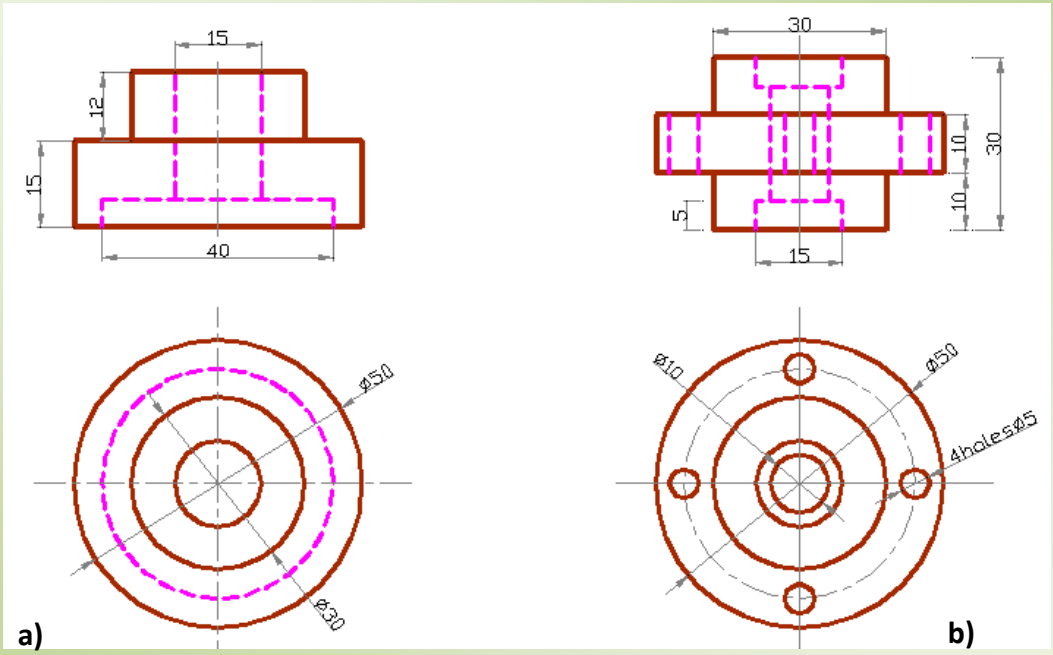
c)

d)

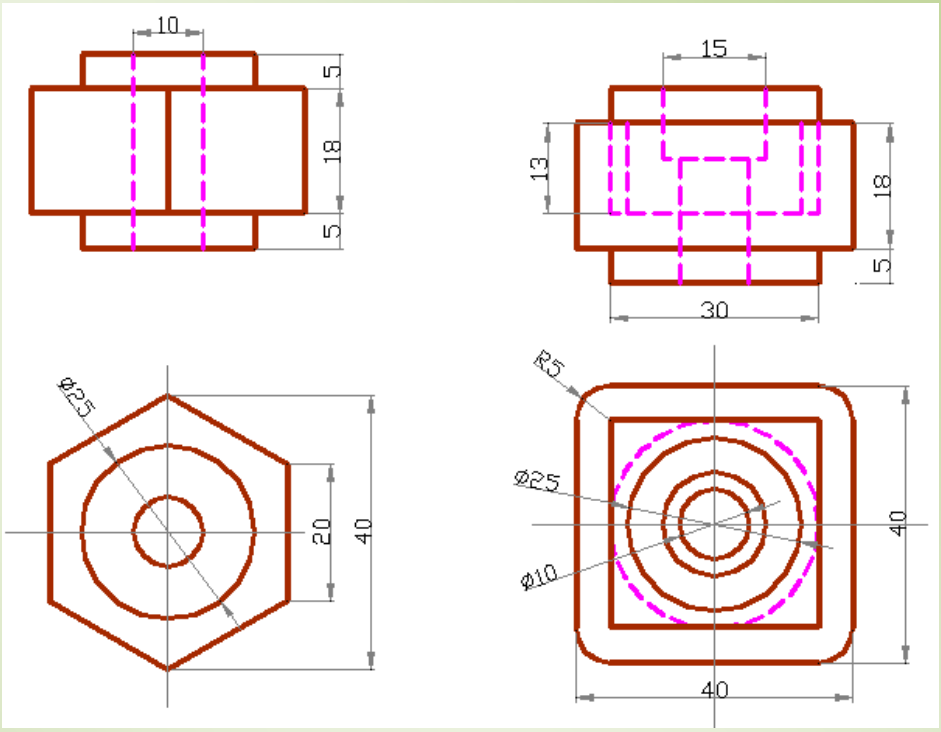


e) f)

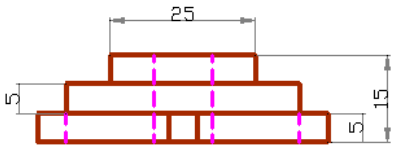
2. For the principal views shown in figure exercise 3.2, draw an appropriate half-section.

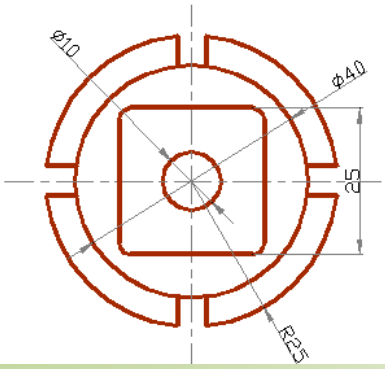


a) b)

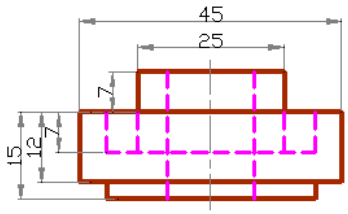

10
5
18
5
15
13
18
5
30
Ø25
20
40
R5
Ø25
Ø10
40
40

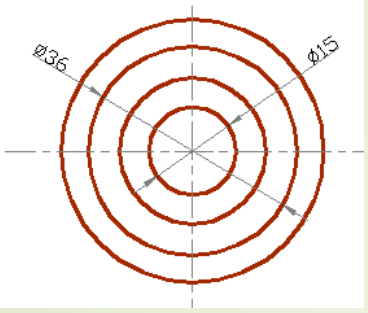
c)


25
5
5
15


Ø10
Ø40
25
R25

d)

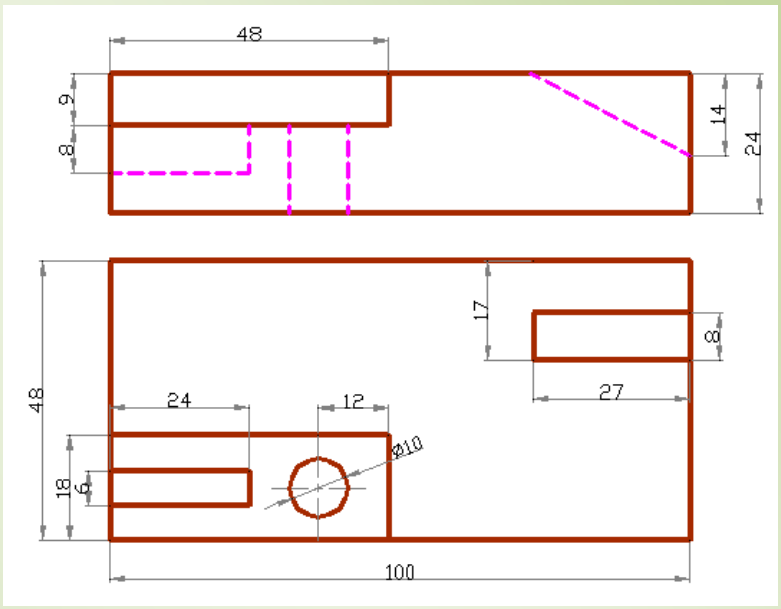

45
25
7
15
12
7


Ø36
Ø15

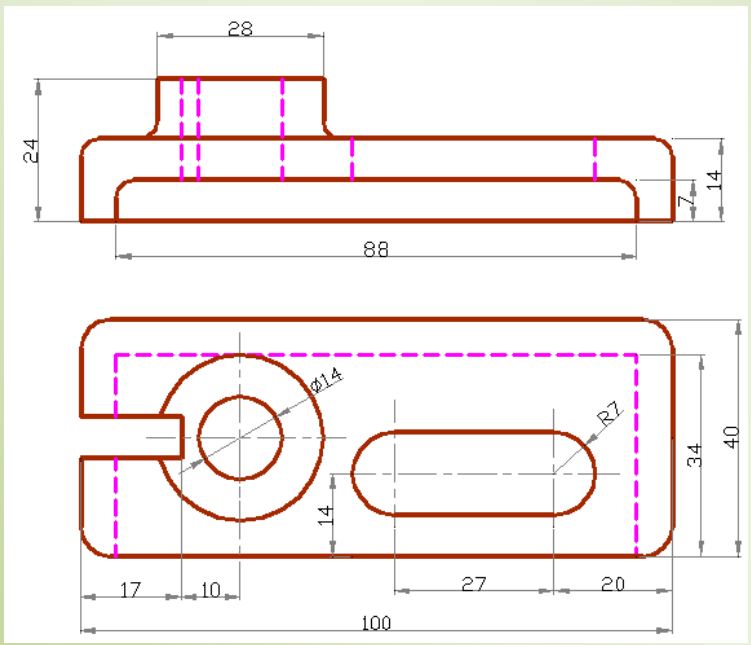
e)

f)

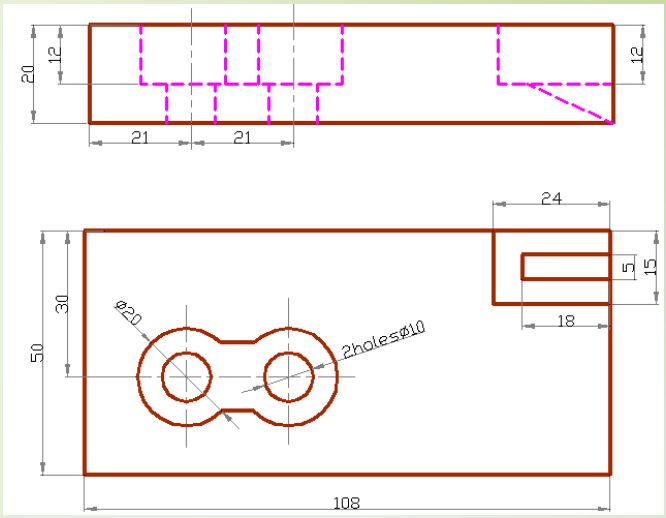
3. For the principal views shown in the figure of exercise 3.3 choose an appropriate offset cutting plane line to show the front views in section



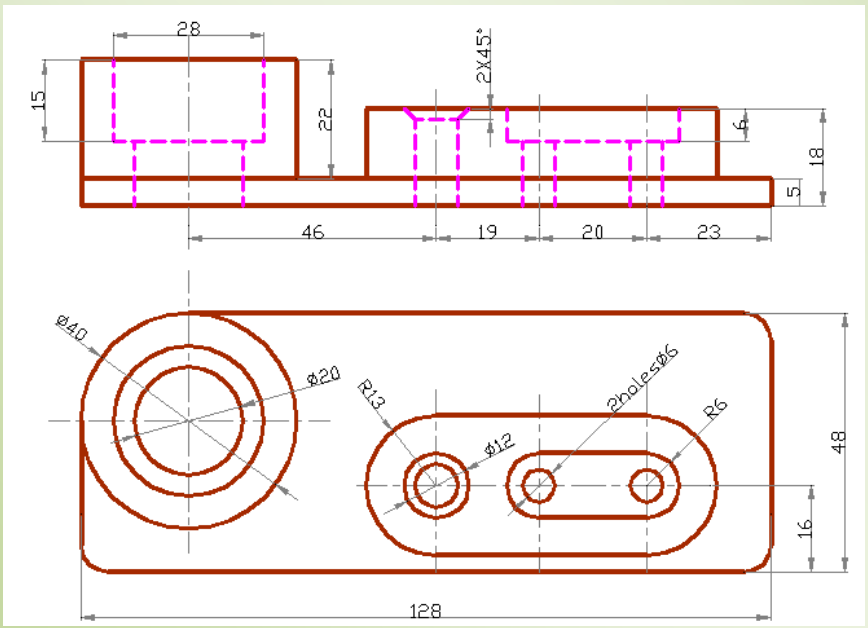
a)



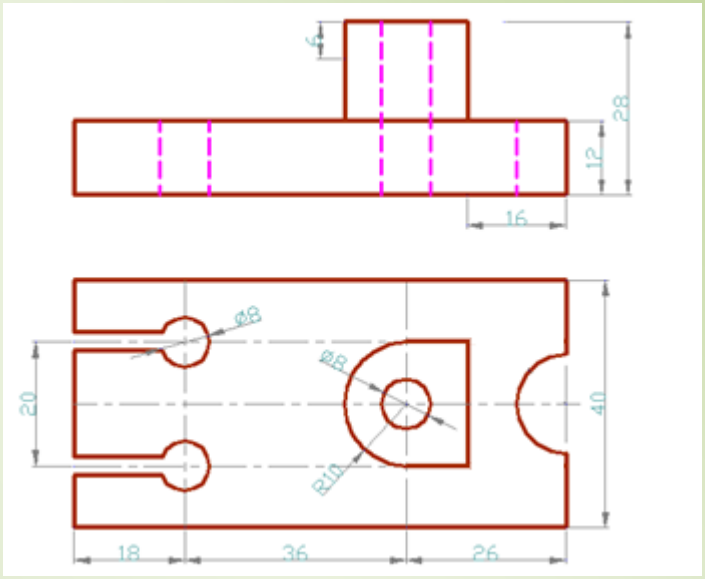
b)



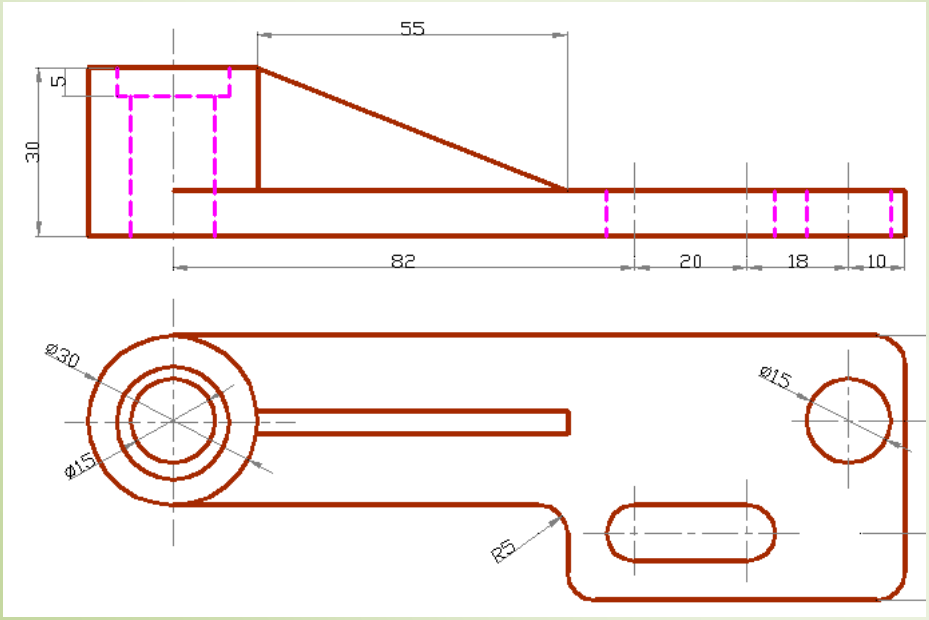
c)



d)



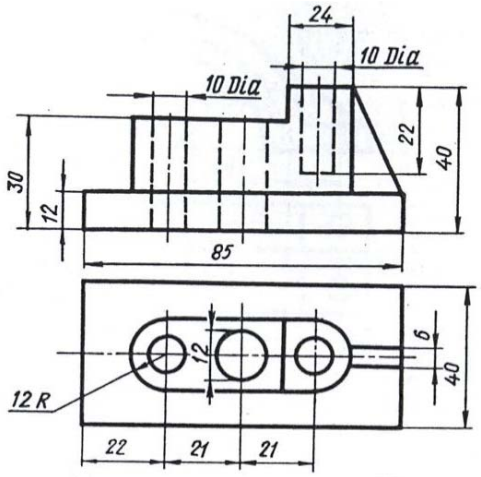
e)



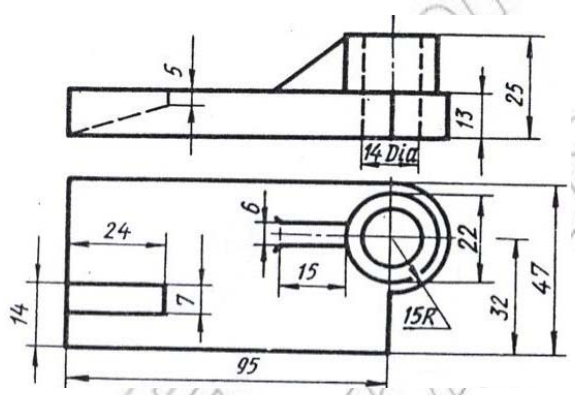
f)

Project I

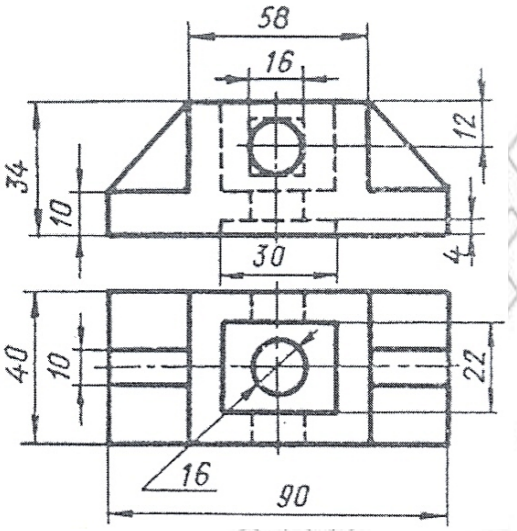
Two views of a model are given in each of the following cases. Replace one of the views using either ***Full, Half or Off-set sectional view*** *and show your* ***cutting plan line.***



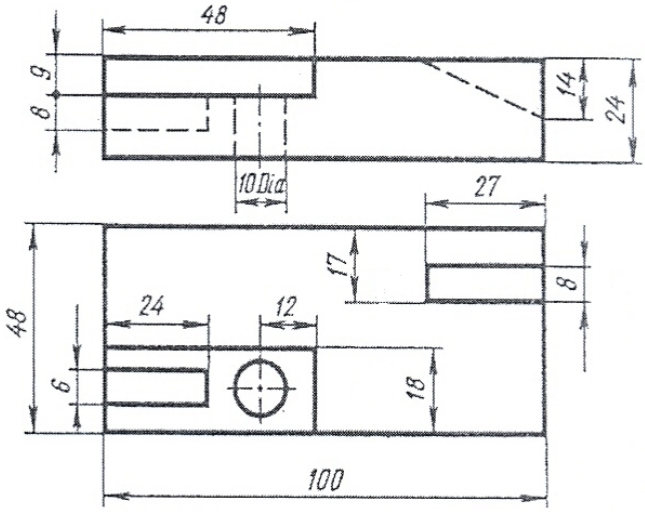
1.



2.



3.



4.