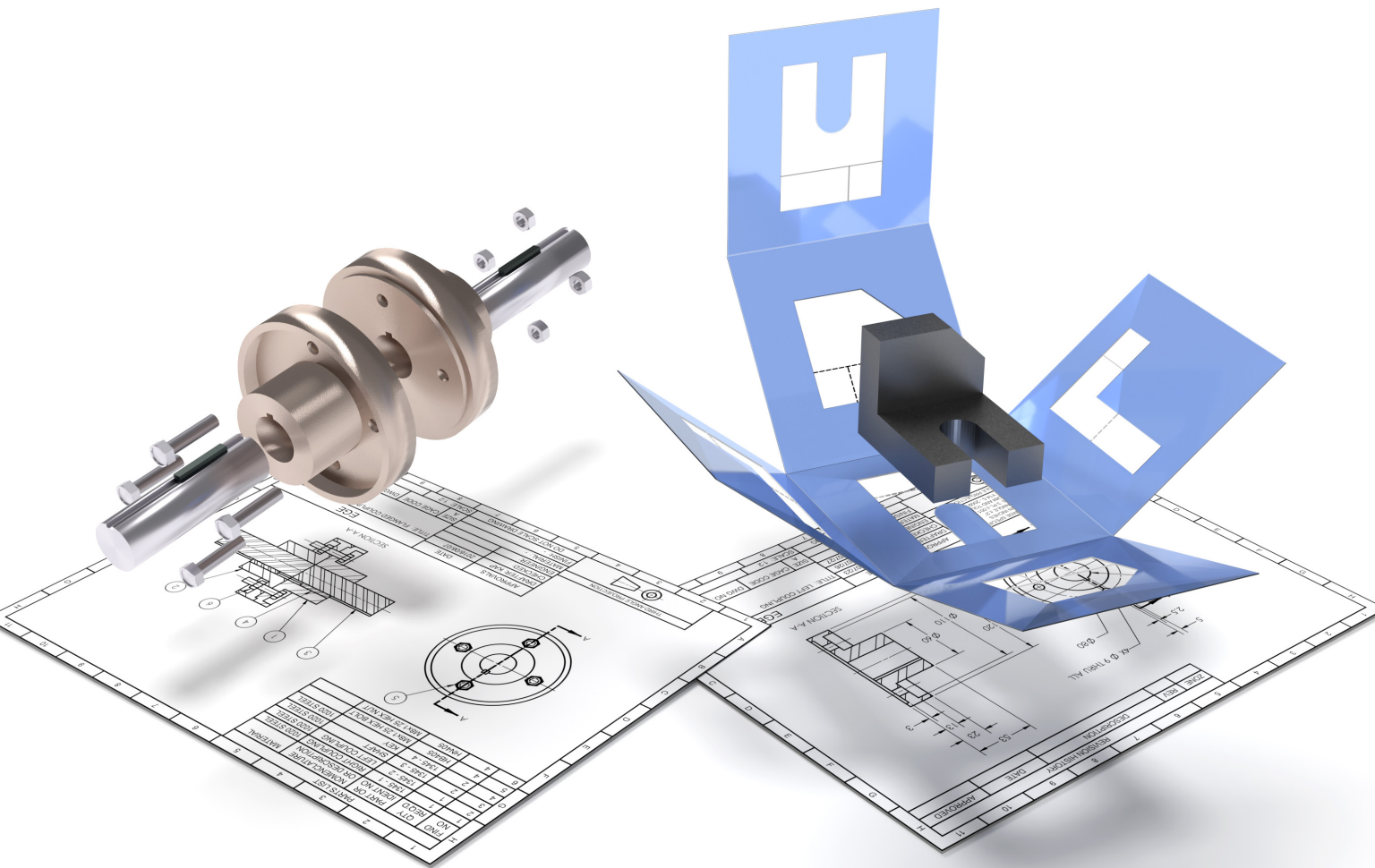


ENGINEERING GRAPHICS ESSENTIALS

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CHAPTER 2

READING ORTHOGRAPHIC PROJECTIONS

CHAPTER OUTLINE

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2.2) THE GLASS BOX METHOD	3
2.3) LINE TYPES USED IN AN ORTHOGRAPHIC PROJECTION.....	7
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CHAPTER SUMMARY

In this chapter, you will learn how to read orthographic projections. An orthographic projection describes the shape of an object. It is a two-dimensional representation of a three-dimensional object. Different line types are used to indicate visible features, hidden features, and symmetry. By the end of this chapter, you will be able to read a technically correct orthographic projection and visualize its three-dimensional form.

2.1) ORTHOGRAPHIC PROJECTION INTRODUCTION

An orthographic projection enables us to represent a three-dimensional object in two dimensions (see Figure 2.1-1). An orthographic projection is a drawing that shows different sides of an object on a sheet of paper (i.e., in two dimensions). The drawing is formed by projecting the edges of the object onto a projection plane from different viewing perspectives.

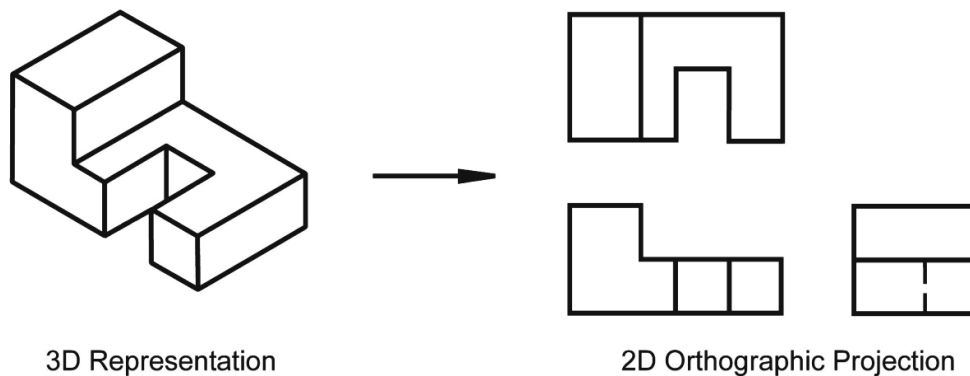


Figure 2.1-1: Orthographic projection.

2.1.1) The Six Principal Views

The six principal viewing directions of an orthographic projection and their associated view names are shown in Figure 2.1-2. These viewing directions are used to create the six principal views. Each principal view is created by looking at the object in the directions indicated in Figure 2.1-2 and drawing what is seen as well as what is hidden from view.

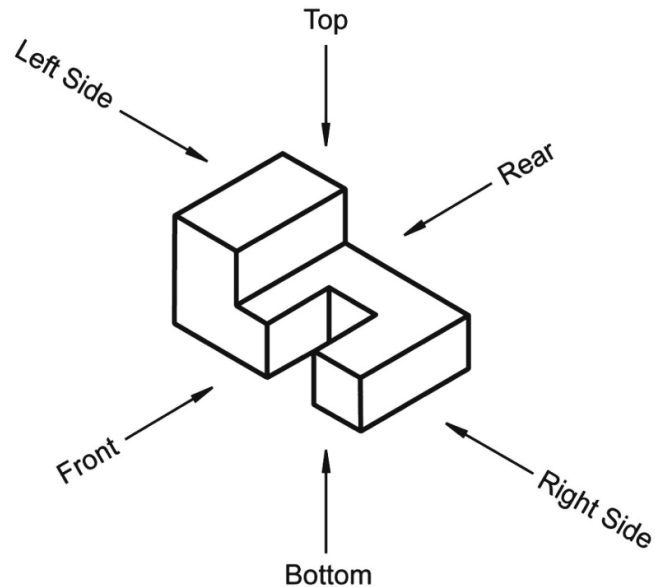


Figure 2.1-2: The six principal viewing directions

2.2) THE GLASS BOX METHOD

The glass box method is a very convenient way of visualizing how an orthographic projection is created. To obtain an orthographic projection, an object is placed in an imaginary glass box as shown in Figure 2.2-1. The sides of the glass box represent the six principal planes. Images of the object are projected onto the sides of the box to create the six principal views. The box is then unfolded to lie flat, showing all views in a two-dimensional plane. Figure 2.2-2 shows the glass box being unfolded to create the orthographic projection of the object.

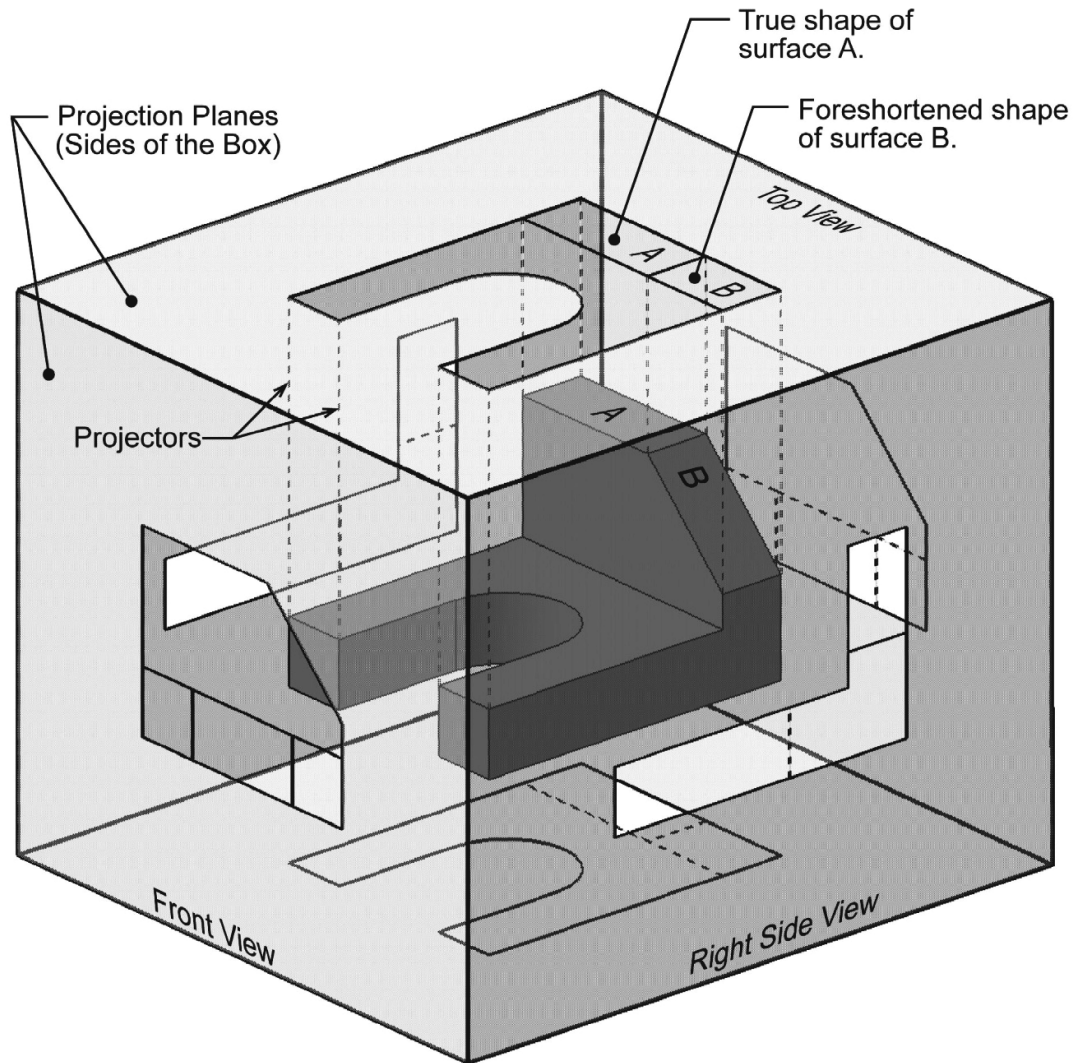


Figure 2.2-1: Object in a glass box

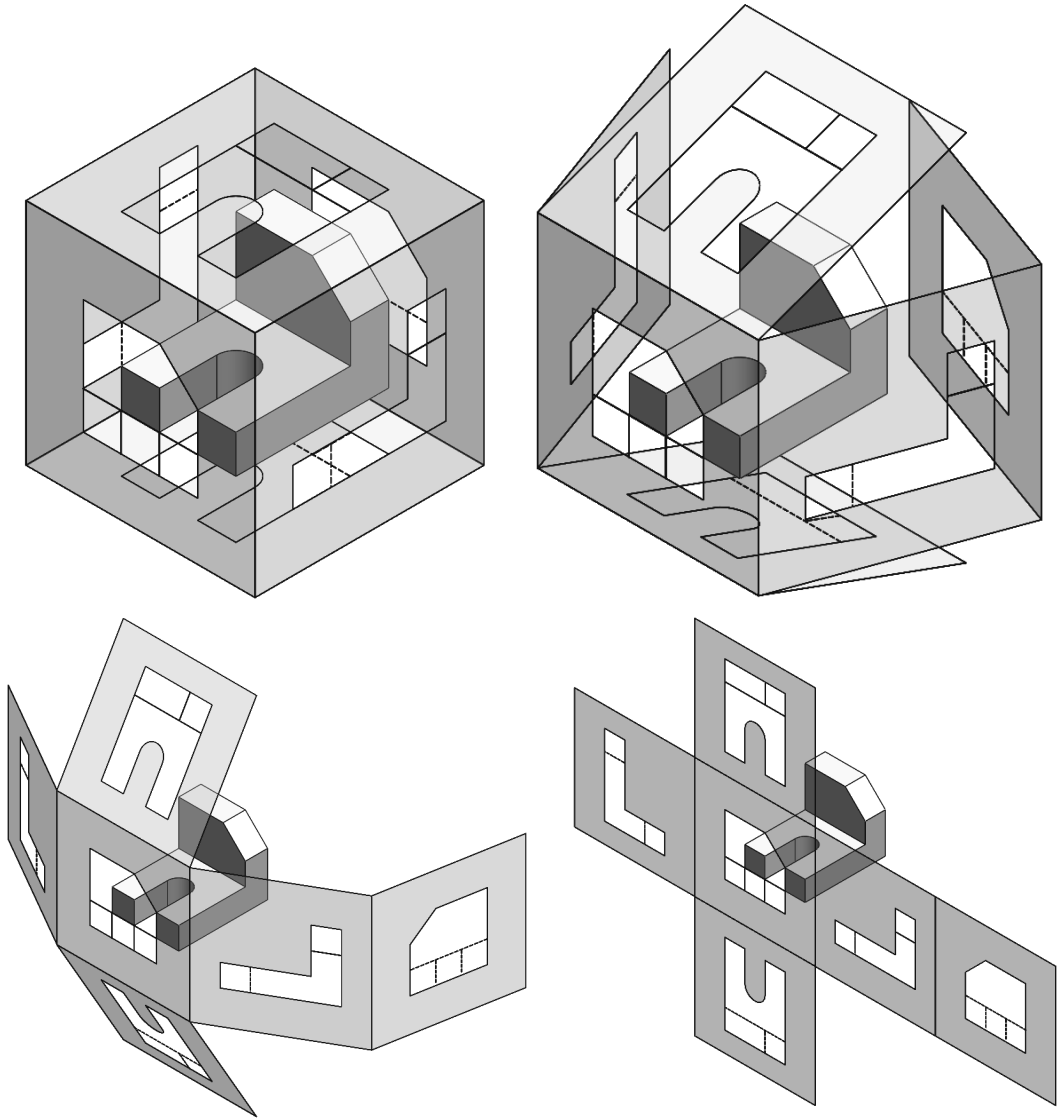
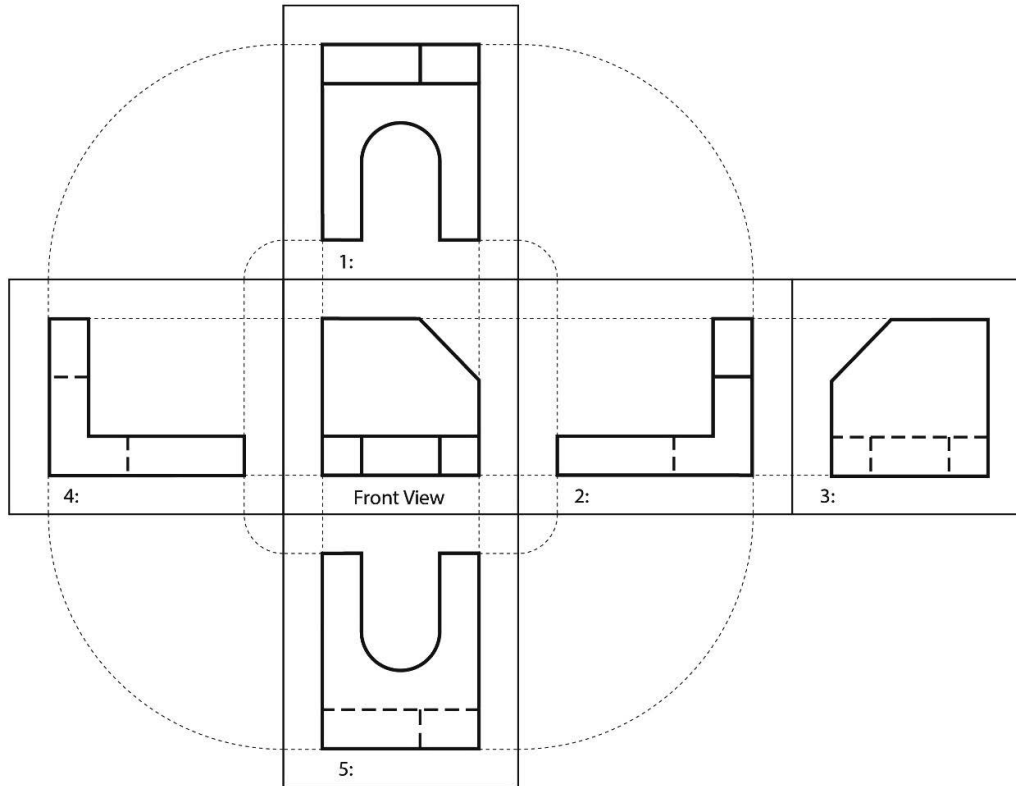


Figure 2.2-2: Glass box being unfolded

Exercise 2.2-1: Principal views

Label the five remaining principal views with the appropriate view name. Figure 2.1-1 indicates the six principal viewing directions as well as their associated view names.



What are the differences between the *Right Side* and *Left Side* views?

What are the differences between the *Top* and *Bottom*, and *Front* and *Rear* views?

Which view(s) have the least number of hidden or dashed lines?

2.3) LINE TYPES USED IN AN ORTHOGRAPHIC PROJECTION

Line type and line weight provide valuable information to the print reader. For example, the type and weight of a line can answer the following questions: Is the feature visible or hidden from view? Is the line part of the object or part of a dimension? Is the line indicating symmetry? There are four commonly used line types: continuous, hidden, center, and phantom. Important lines are thicker than less important thin lines. The following is a list of common line types and widths used in a basic orthographic projection that has no section views or dimensions.

1. **Visible lines:** **Represent visible edges and boundaries.** The visible line type is **continuous**, and the line weight is **thick**. For example, Figure 2.3-1 shows a solid cylinder. Notice that the visible lines are thicker than the center lines.
2. **Hidden lines:** **Represent edges and boundaries that cannot be seen.** The hidden line type is **dashed**, and the line weight is **medium thick**. For example, Figure 2.3-4 shows a part with a hole in it. In the view shown, the hole cannot be seen. So, hidden lines are used to indicate where the hole is located even though it cannot be seen.
3. **Center lines:** **Represent axes, center points, planes of symmetry, circle of centers, and paths of motion.** A *circle of centers* is a circle that indicates where the centers of all the holes in a hole pattern lie. A *path of motion* indicates the path a feature takes when moving from one position to the next. The center line type is **long dash – short dash**, and the line weight is **thin**. Figure 2.3-1 shows center lines being used to indicate axes of symmetry. Figure 2.3-2 shows a center line indicating the line of symmetry on a symmetric part. At the ends of the center line, a symmetry symbol is placed to further emphasize that the part is symmetric. Figure 2.3-3 shows center lines being used for a circle of centers, and Figure 2.3-4 shows a center line indicating the path of motion.

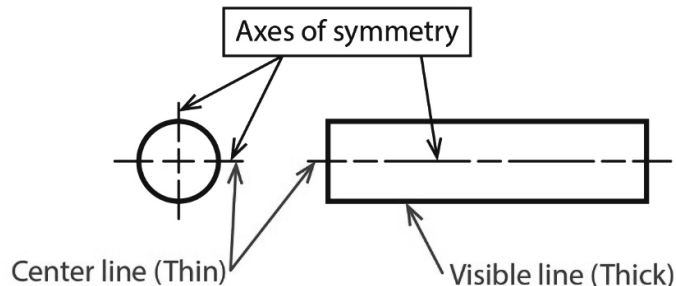


Figure 2.3-1: Axes of symmetry

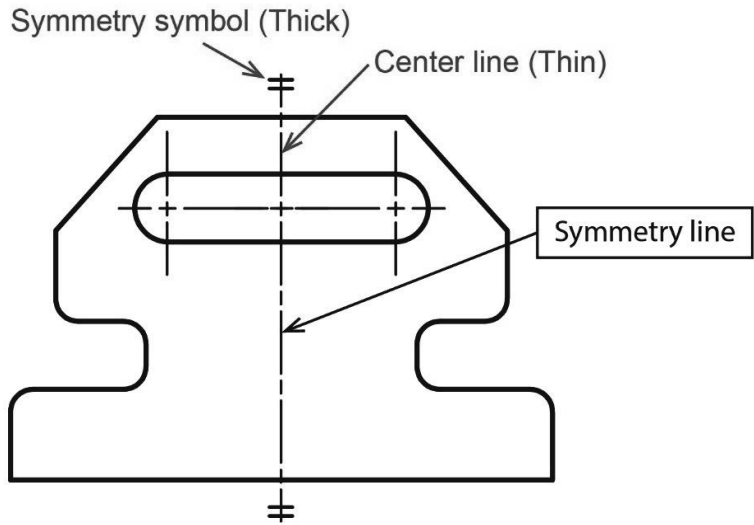


Figure 2.3-2: Part symmetry

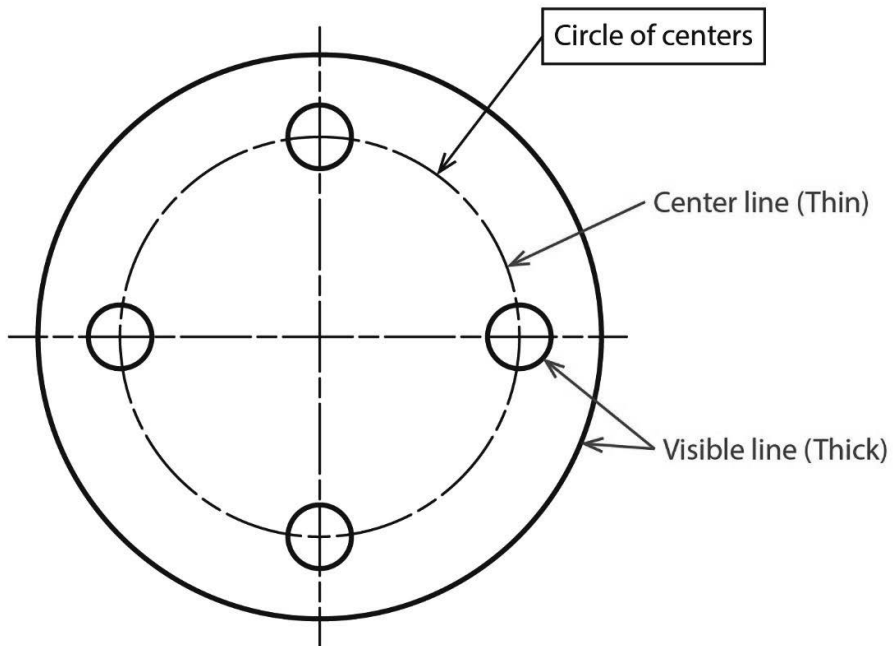


Figure 2.3-3: Circle of centers

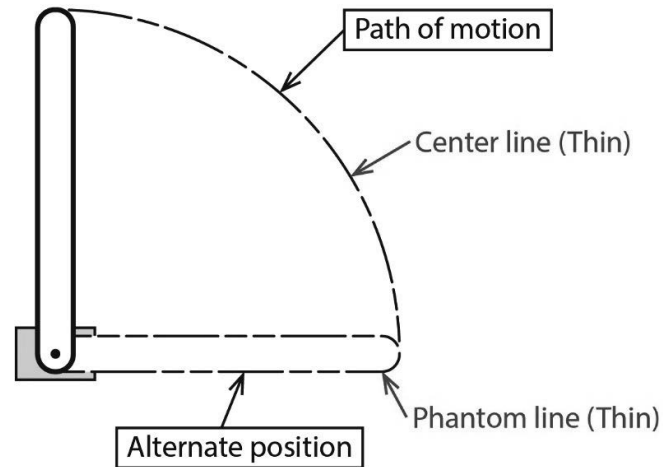


Figure 2.3-4: Paths of motion and alternate position

4. **Phantom lines:** Used to indicate imaginary features such as alternate positions of moving parts, adjacent positions of related parts, repeated detail, reference planes between adjacent views, and filleted and rounded corners. The line type is **long dash – short dash – short dash**, and the line weight is usually **thin**. Figure 2.3-2 shows a rotating bar. Phantom lines are used to show an alternate position of the bar. Figure 2.3-5 shows a part outlined in visible lines. This is the part that is being described. The part that it is sitting on is a related part shown in phantom lines. This part is not being described. The purpose is only to show how they mate. Figure 2.3-6 shows a spring whose center coils are omitted, and a phantom line is used to indicate repeated details. Figure 2.3-7 shows phantom lines being used to indicate changes in surface direction.

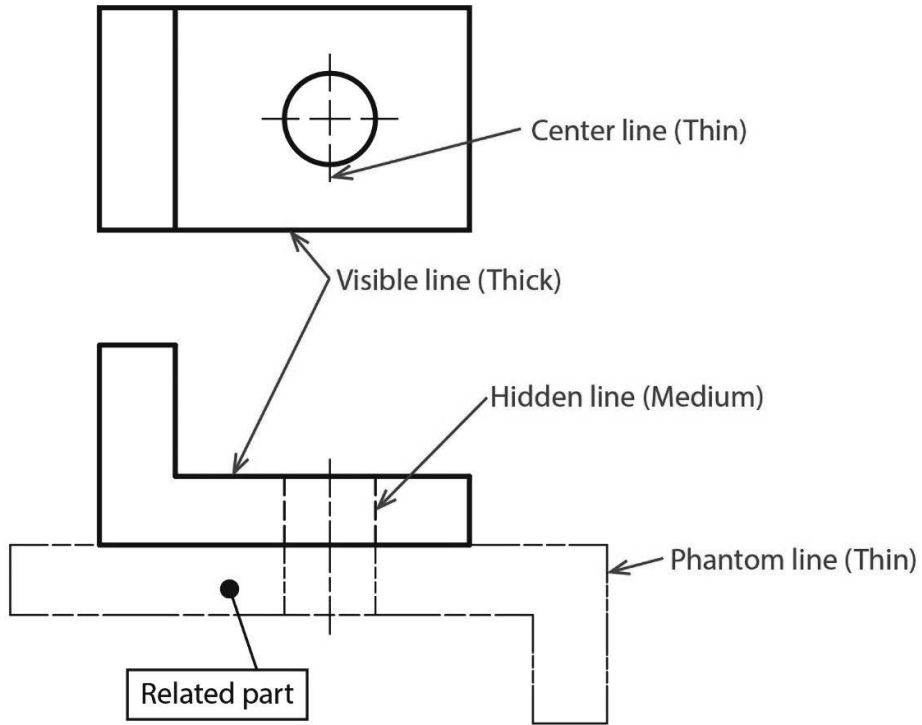


Figure 2.3-5: Related part.



Figure 2.3-6: Repeated detail.

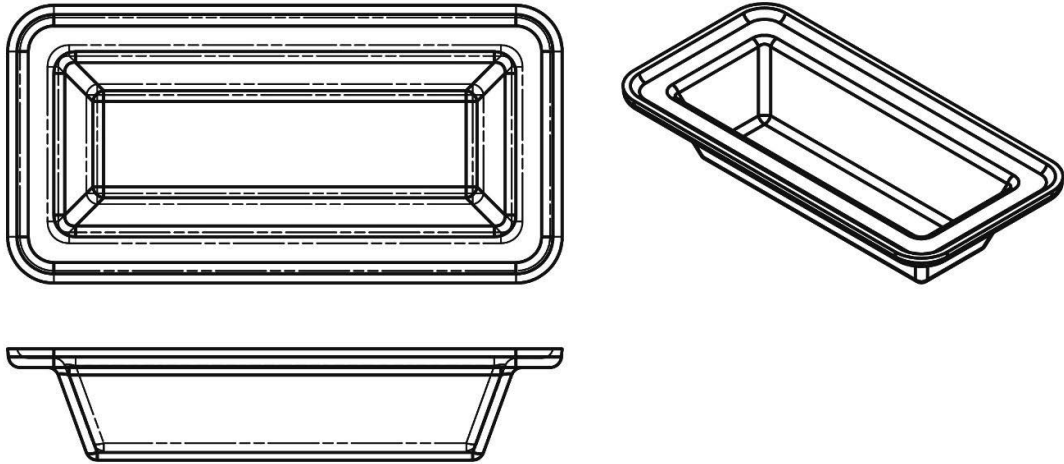


Figure 2.3-7: Phantom lines used to indicate a change in surface direction.

5. **Break lines:** Used to show imaginary breaks in objects. A break line is usually made up of a series of connecting arcs. The line type is **continuous**, and the line weight is usually **thick**. Figure 2.3-8 shows an eye bolt with a long shaft. Drawing the entire shaft will not give the reader any extra information. Therefore, a break line is used to break and shorten the shaft.

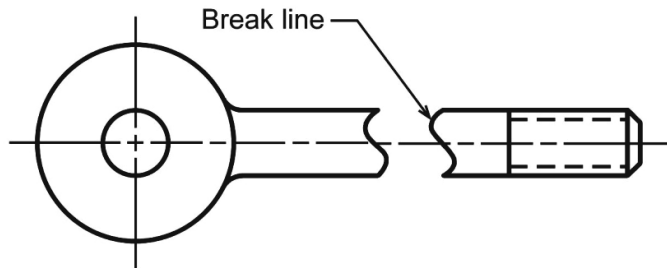


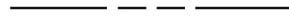
Figure 2.3-8: Using break lines.

Try Exercise 2.3-1, 2.3-2, 2.3-3, and 2.3-4

Exercise 2.3-1: Line types

Using the line type definitions, match each line type name with the appropriate line type.

- Visible Line



- Hidden Line



- Center Line



- Phantom Line

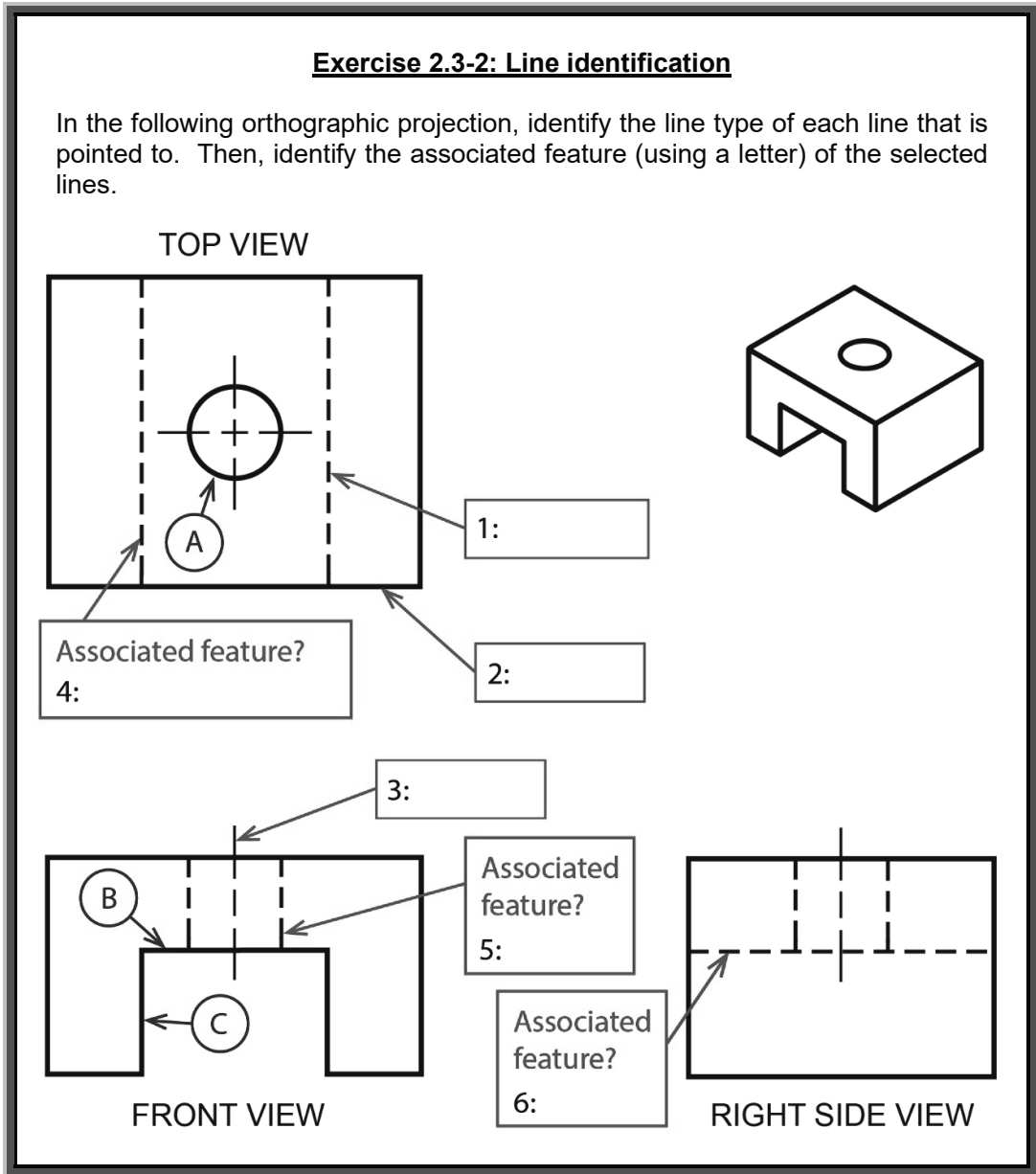


- Break Line



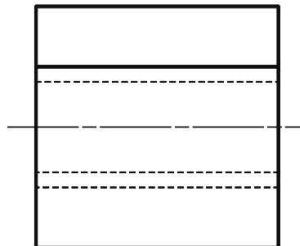
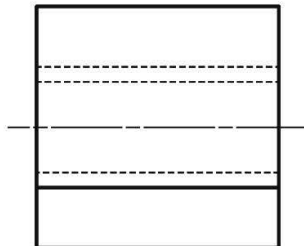
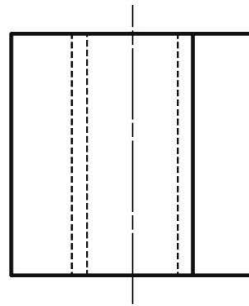
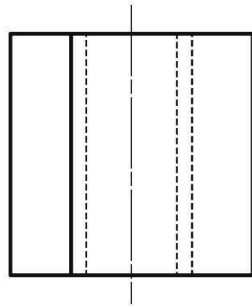
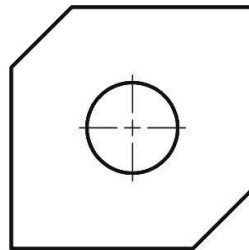
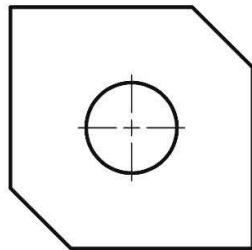
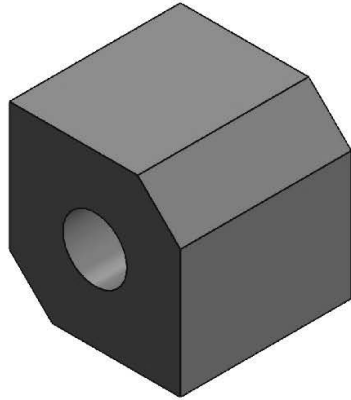
Exercise 2.3-2: Line identification

In the following orthographic projection, identify the line type of each line that is pointed to. Then, identify the associated feature (using a letter) of the selected lines.



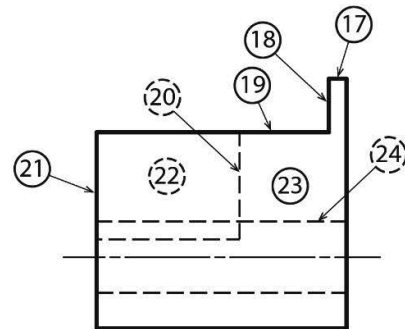
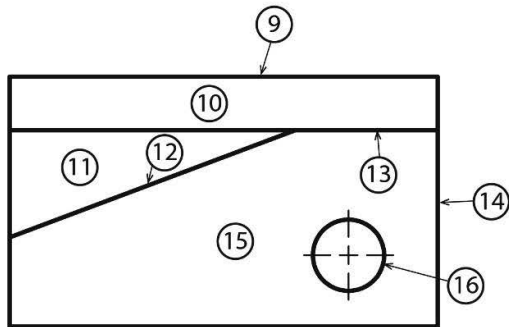
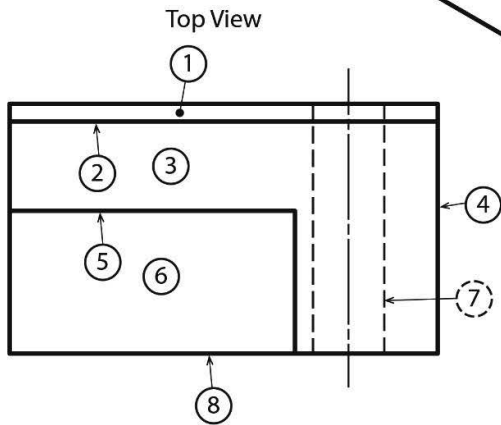
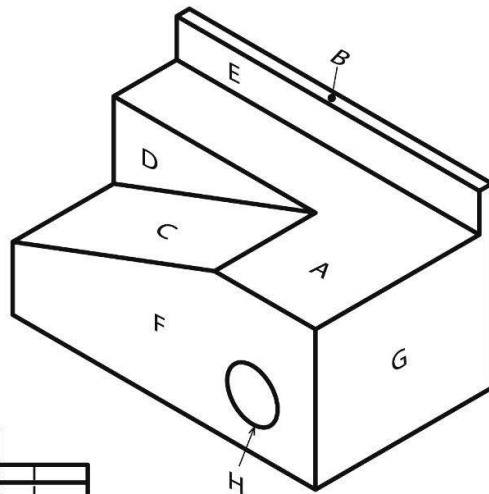
Exercise 2.3-3: View Identification

Match the object with its correct front, top and right-side views. Note that views should not be aligned on an orthographic projection as shown in this problem.



Exercise 2.3-4: Surface Identification

In the following orthographic projection, identify the surfaces identified in the pictorial on the shown views.



Front View

Right Side View

	A	B	C	D	E	F	G	H
Top								
Front								
Right Side								

2.4) PROJECTION SYMBOL

The two internationally recognized systems of projection used to create orthographic projections are third-angle projection and first-angle projection. In the United States, we use third-angle projection to create an orthographic projection. In some parts of Europe, and elsewhere, first-angle projection is used. To inform the print reader what projection method was used to create the drawing, the projection symbol is placed in the projection block. **If the drawing uses metric units, the text “SI” is placed in front of the projection symbol.** The projection block is placed to the left of the title block. The projection symbols are shown in Figure 2.4-1.

It is extremely important that the print reader knows which projection method was used to create the orthographic projection. Without knowledge of the projection method, reading a drawing may be confusing and lead to interpretation mistakes. The glass box method described in a previous section will produce a drawing in third-angle projection. Figure 2.4-2a and b show an object represented in both third-angle and first-angle projection. What differences do you see between the two methods?

To understand and visually see how views are created using the third-angle projection standard, put your right hand on a table palm up. You are looking at the front view of your hand. Now rotate your hand so that your thumb points up and your little finger is touching the table. This is the top view of your hand. Put your hand back in the front view position. Now rotate your hand so that your finger tips are pointing down and your wrist is off the table. This is the right side view of your hand. Now let's see how that changes when we are creating a first-angle projection drawing. Put your right hand on the table with your palm down. The back of your hand is the front view. Now, rotate your hand so that your thumb is pointing up and your little finger is on the table. This is the top view of your hand. Put your hand back in the front view position. Rotate your hand so that your fingers are pointing up. This is the right side view of your hand. To be more technical, **third-angle projection** forms the orthographic projection by placing the projection plane between the object and the observer and **first-angle projection** places the object between the observer and the projection plane. Note that the geometry of the views for both first-angle and third-angle projections are the same, it is just the placement of the views that are different.

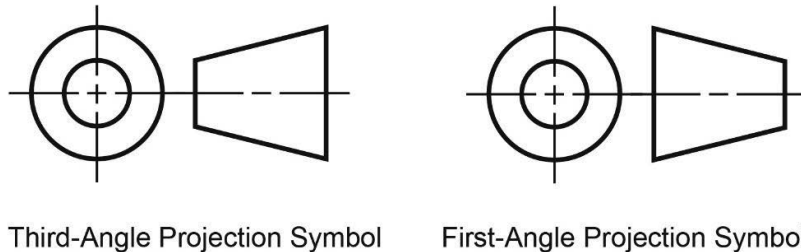


Figure 2.4-1: First and third-angle projection symbols

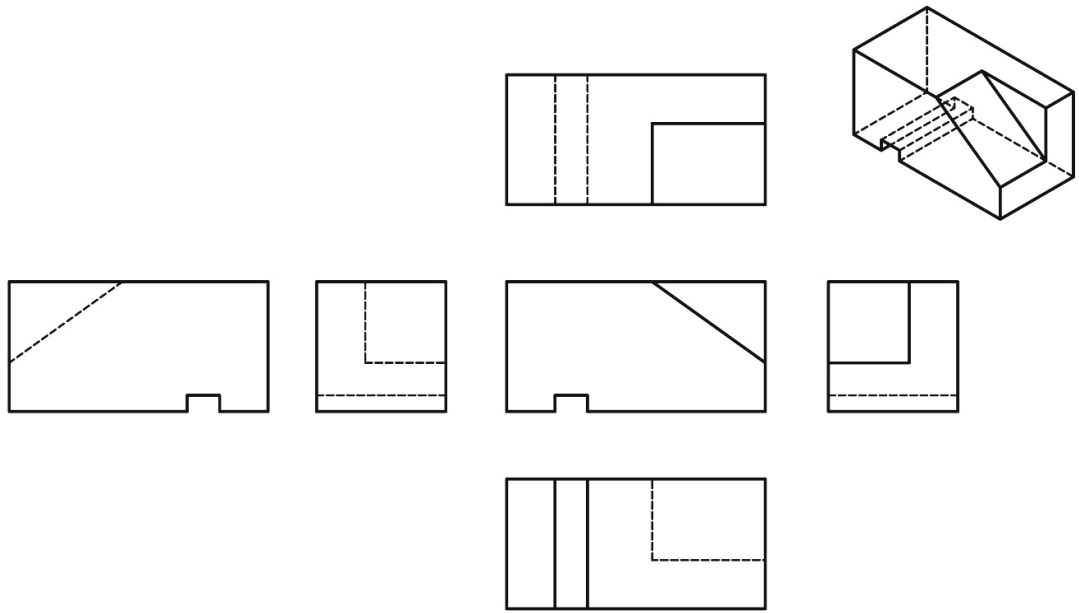


Figure 2.4-2a: Third-angle projection method

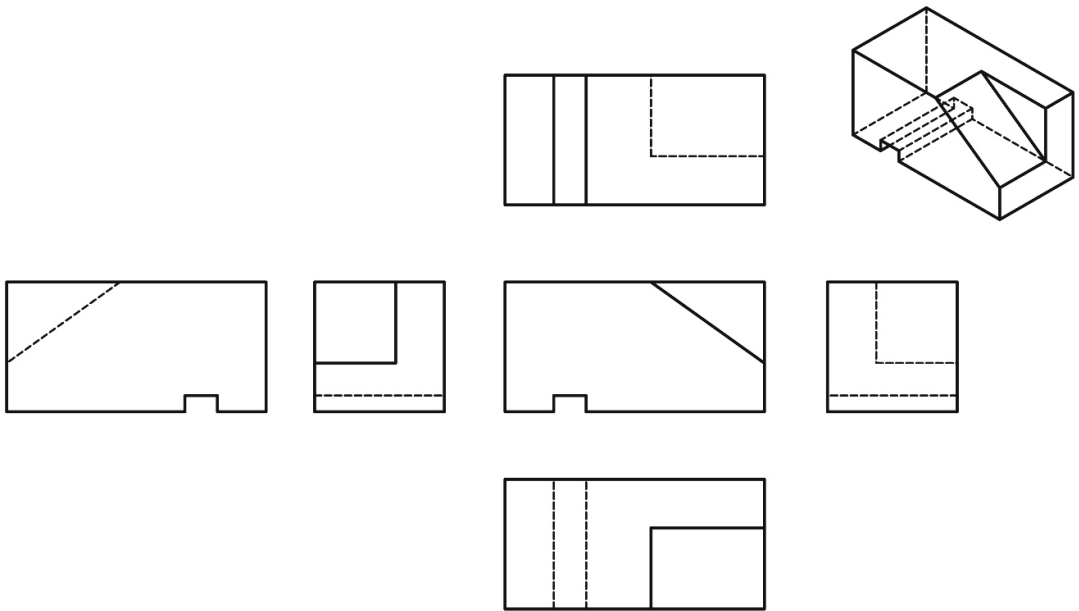
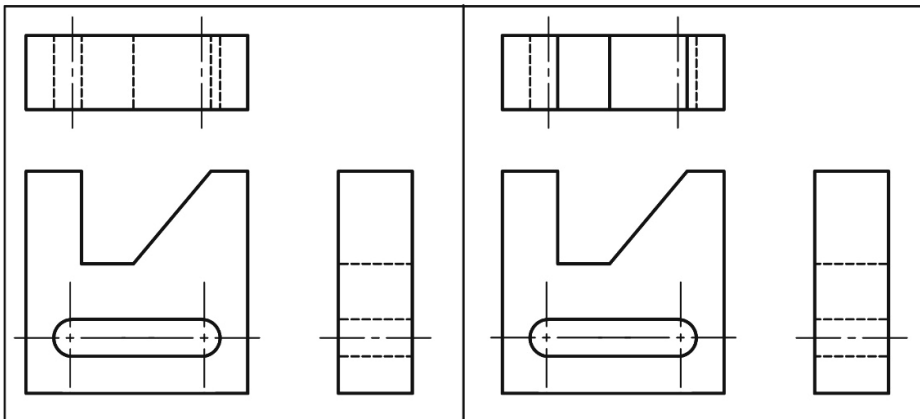
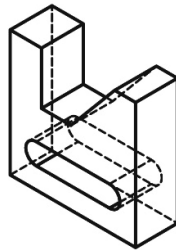
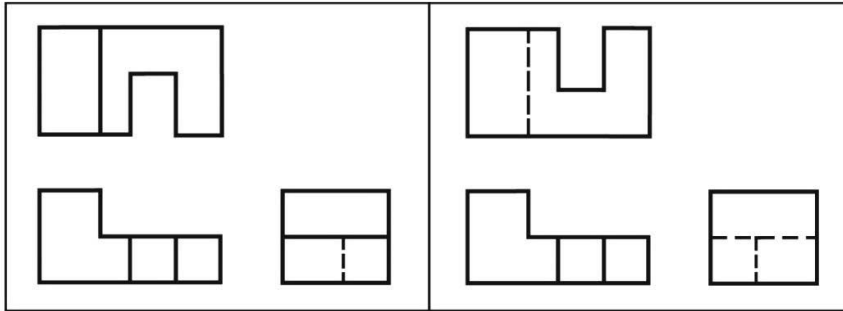
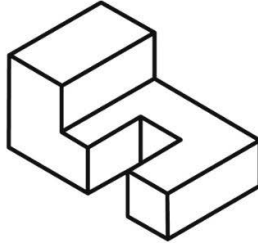


Figure 2.4-2b: First-angle projection method

Try Exercise 2.4-1.

Exercise 2.4-1: Projection methods

Identify which drawing was created using third-angle projection and which was created using first-angle projection.



READING ORTHOGRAPHIC PROJECTIONS QUESTIONS – SET1

Name: _____ Date: _____

Orthographic projection and principal views

Q2-1) An orthographic projection is a _____ representation of a three-dimensional object. Fill in the blank.

Q2-2) What are the standard views?

- _____
- _____
- _____

Line types

Q2-3) Line type provides valuable information to the print reader. (True, False)

Q2-4) Visible lines are used to indicate ...

- a) edges and boundaries that you can see.
- b) edges and boundaries that you cannot see.
- c) imaginary features.
- d) symmetric features.

Q2-5) Hidden lines are used to indicate ...

- a) edges and boundaries that you can see.
- b) edges and boundaries that you cannot see.
- c) imaginary features.
- d) symmetric features.

Projection methods

Q2-6) In the United States, is 1st or 3rd angle projection used as the standard?

NOTES:

READING ORTHOGRAPHIC PROJECTIONS QUESTIONS – SET2

Q2-7) List the 6 principal views.

- _____
- _____
- _____
- _____
- _____
- _____

Q2-8) The FRONT and TOP views are aligned (vertically, horizontally). Circle the correct answer.

Q2-9) The FRONT and RIGHT SIDE views are aligned (vertically, horizontally). Circle the correct answer.

Q2-10) Line weight does not provide any information to the print reader. (True, False)

Q2-11) Center lines are used to indicate (Circle all that apply.)

- a) axes of symmetry.
- b) paths of motion.
- c) circle of centers.
- d) change in surface direction.

Q2-12) Phantom lines are used to indicate (Circle all that apply.)

- a) alternate positions.
- b) repeated detail.
- c) related parts.
- d) change in surface direction.

Q2-13) Break lines are used to show an imaginary _____ in an object.

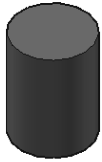
Q2-14) The symbol “SI” that is placed in front of the projection symbol lets us know that the drawing is using (inches, mm). Circle the correct answer.

Q2-15) The projection symbol, indicating the projection method used to create the drawing, is placed in the _____ block. Fill in the blank.

READING ORTHOGRAPHIC PROJECTIONS PROBLEMS

Name: _____ Date: _____

P2-1) Match the solid part with its correct orthographic projection.



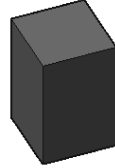
A



B



C



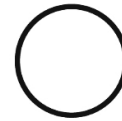
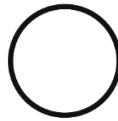
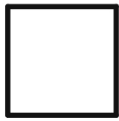
D



E



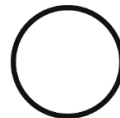
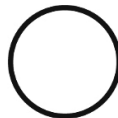
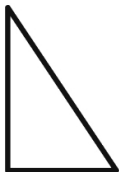
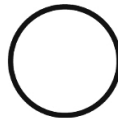
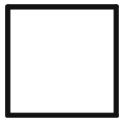
F



1. _____

2. _____

3. _____



4. _____

5. _____

6. _____

NOTES:

Name: _____ Date: _____

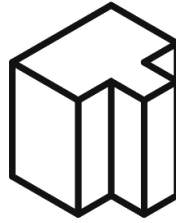
P2-2) Match the solid part with its correct orthographic projection.



A



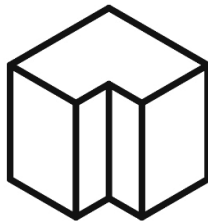
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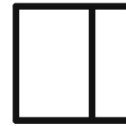
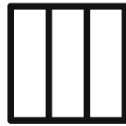
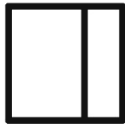
C



D



E



1. _____

2. _____

3. _____



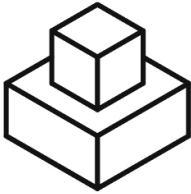
4. _____

5. _____

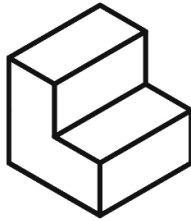
NOTES:

Name: _____ Date: _____

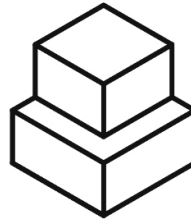
P2-3) Match the solid part with its correct orthographic projection.



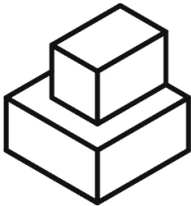
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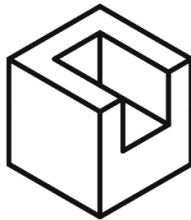
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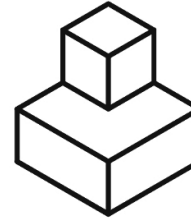
C



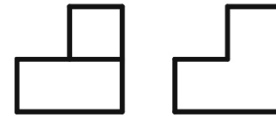
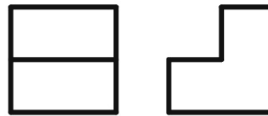
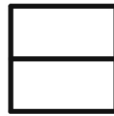
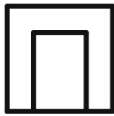
D



E



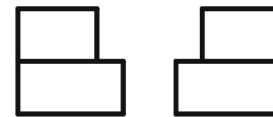
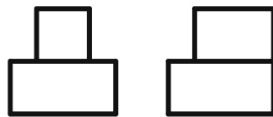
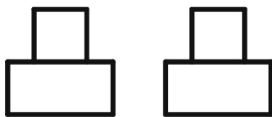
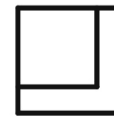
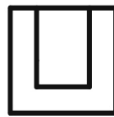
F



1. _____

2. _____

3. _____



4. _____

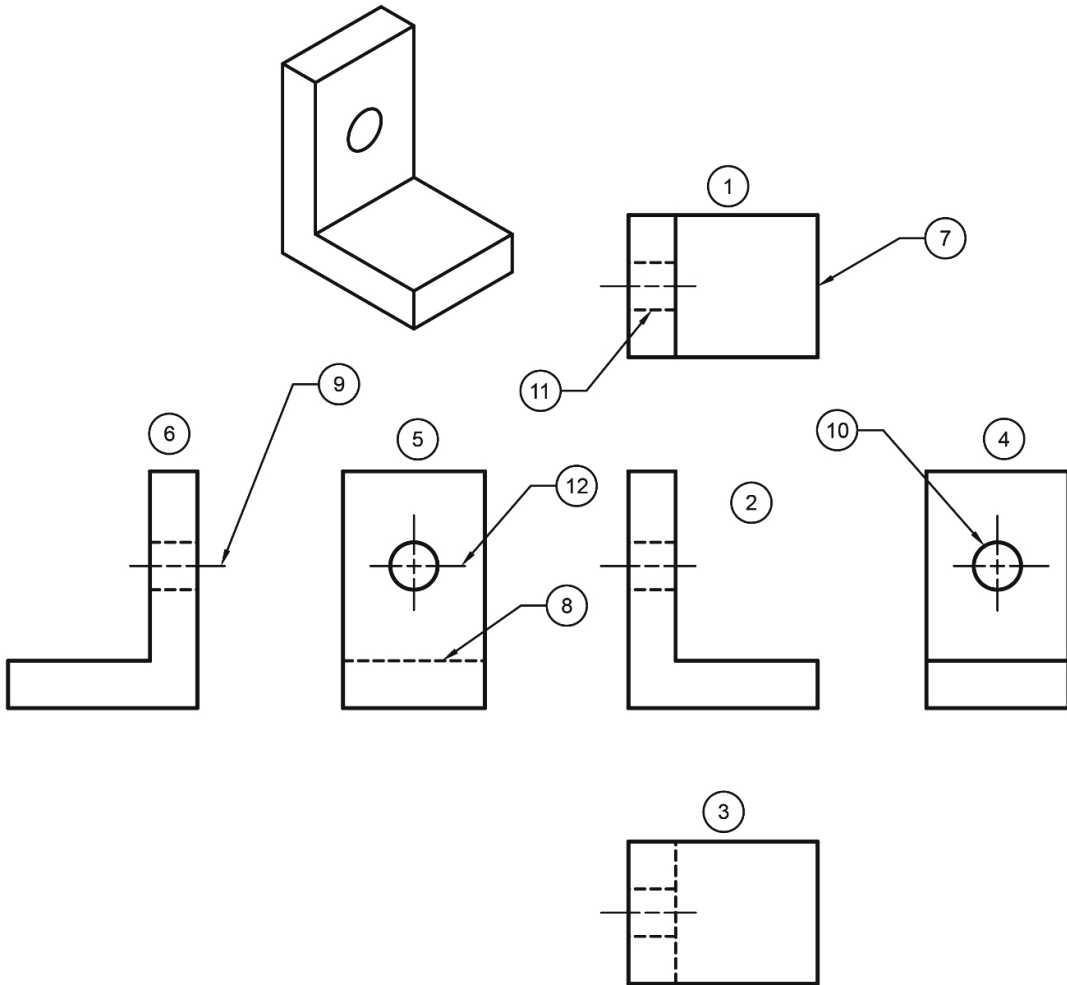
5. _____

6. _____

NOTES:

Name: _____ Date: _____

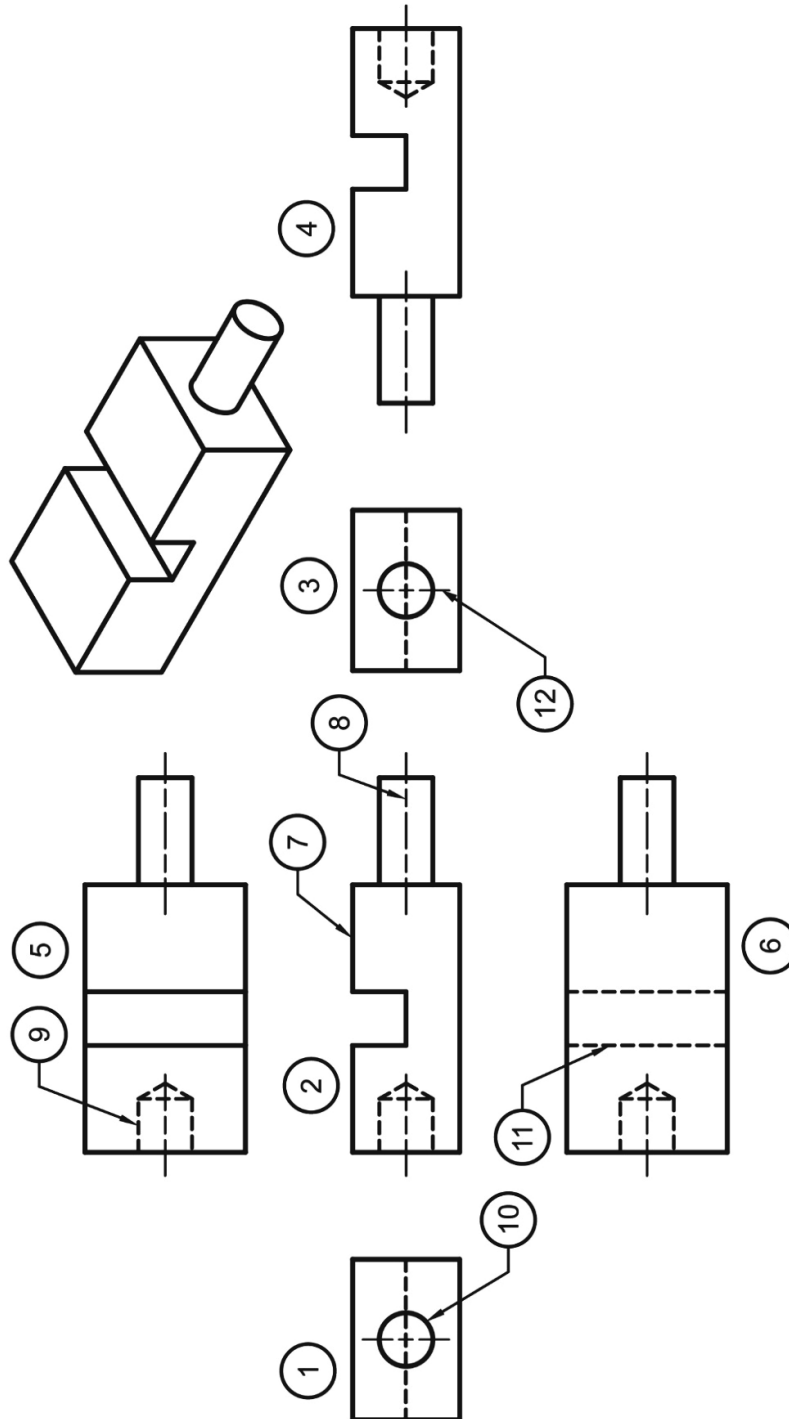
P2-4) Answer the following question related to the orthographic projection shown. Note that the front view is vertically aligned with the top and bottom view and horizontally aligned with the right-side view, left-side view, and the rear view.



1. View name	
2. View name	
3 View name	
4. View name	
5. View name	
6. View name	
7. Line type	
8. Line type	
9. Line type	
10. Line type	
11. Line type	
12. Line type	

Name: _____ Date: _____

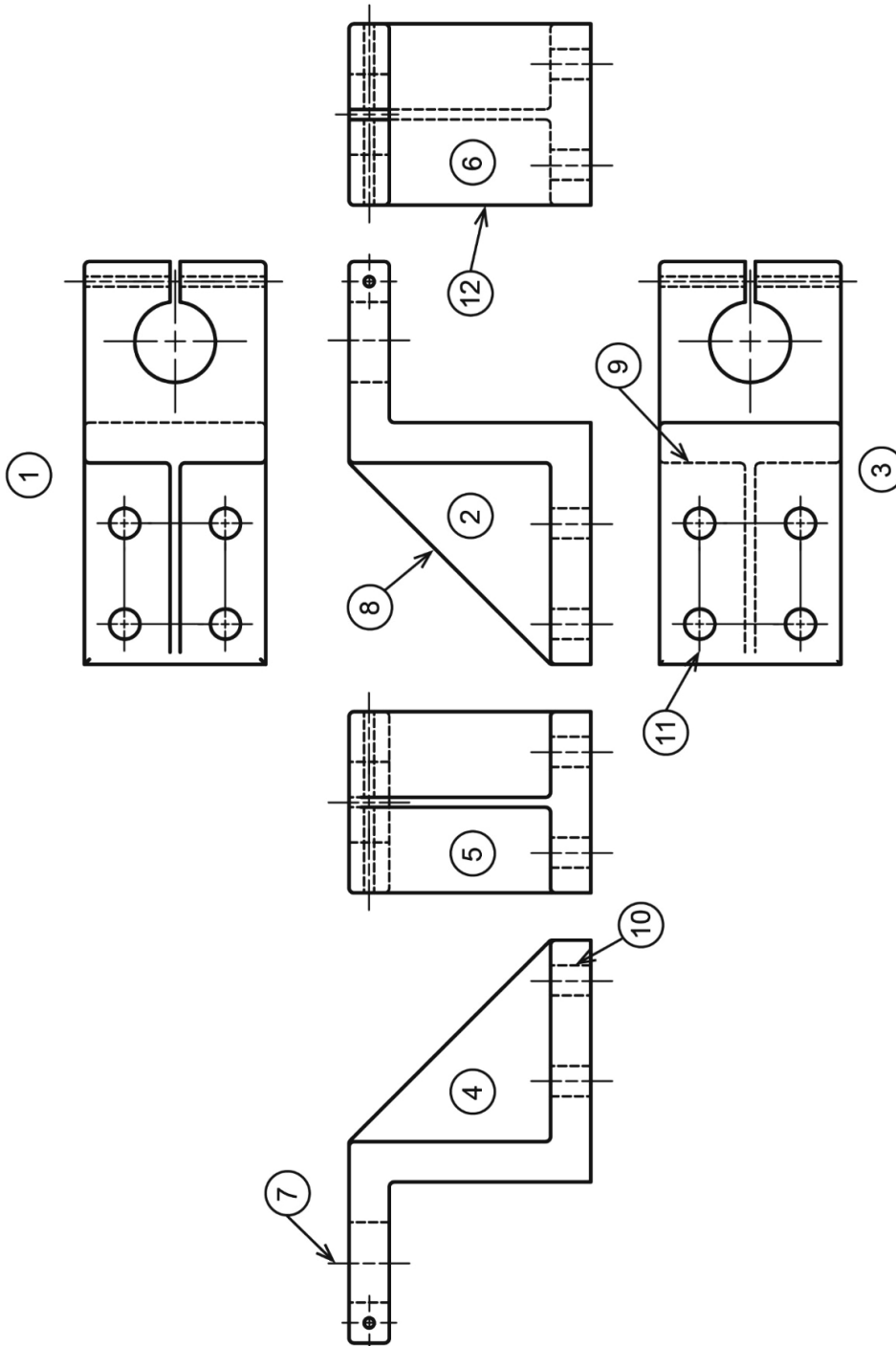
P2-5) Answer the following question related to the orthographic projection shown. Note that the front view is vertically aligned with the top and bottom view and horizontally aligned with the right-side view, left-side view, and the rear view.



1. View name	
2. View name	
3 View name	
4. View name	
5. View name	
6. View name	
7. Line type	
8. Line type	
9. Line type	
10. Line type	
11. Line type	
12. Line type	

Name: _____ Date: _____

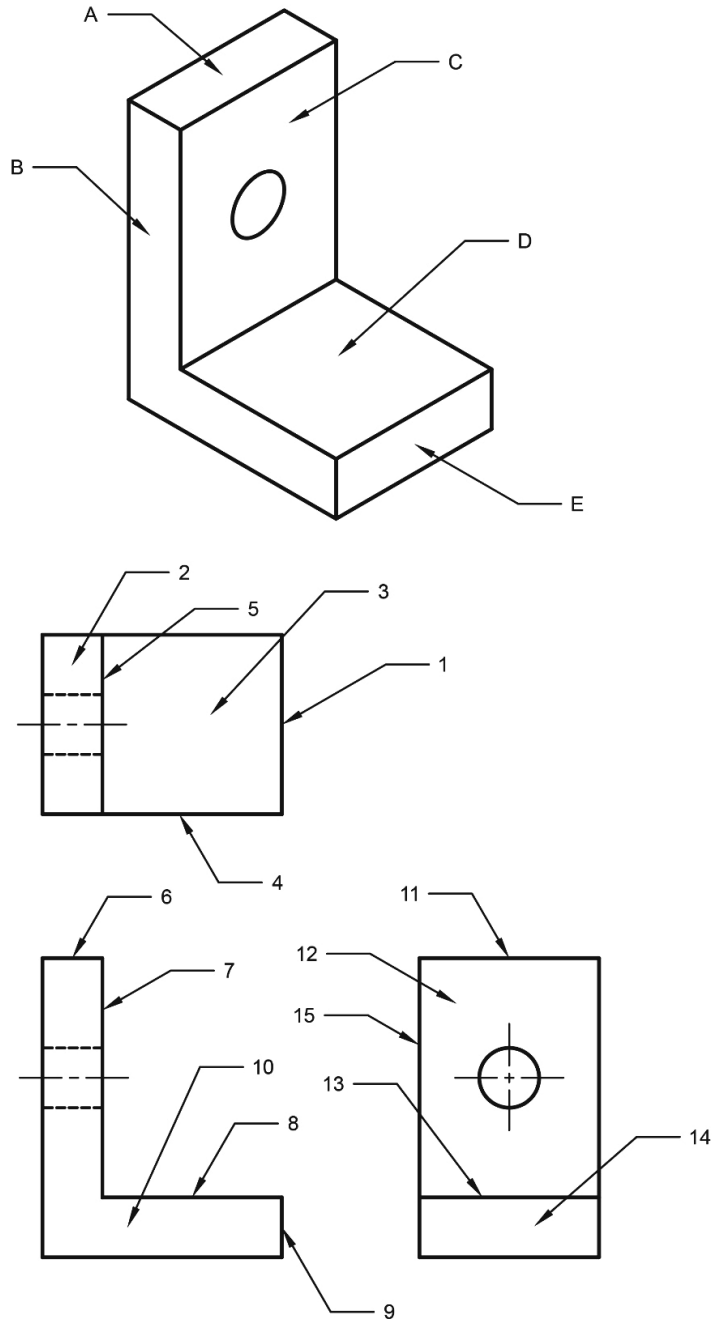
P2-6) Answer the following question related to the orthographic projection shown. Note that the front view is vertically aligned with the top and bottom view and horizontally aligned with the right-side view, left-side view, and the rear view.



1. View name	
2. View name	
3 View name	
4. View name	
5. View name	
6. View name	
7. Line type	
8. Line type	
9. Line type	
10. Line type	
11. Line type	
12. Line type	

Name: _____ Date: _____

P2-7) Match the numbers in the orthographic projection with the letters in the pictorial.

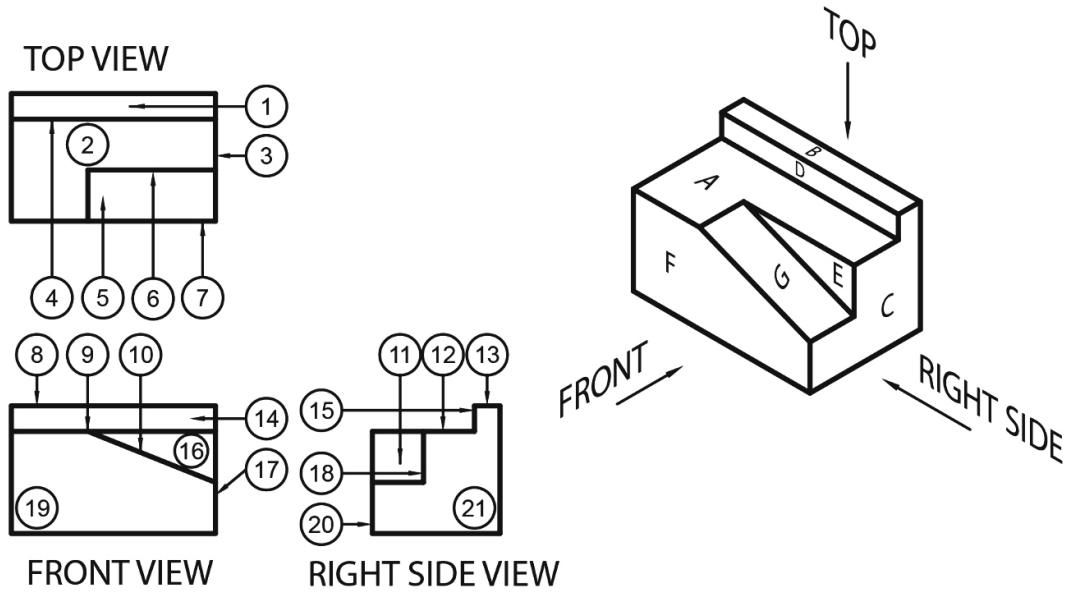


	A	B	C	D	E
FRONT			7		
TOP			5		
RIGHT SIDE			12		

NOTES:

Name: _____ Date: _____

P2-8) Match the numbers in the orthographic projection with the letters in the pictorial.

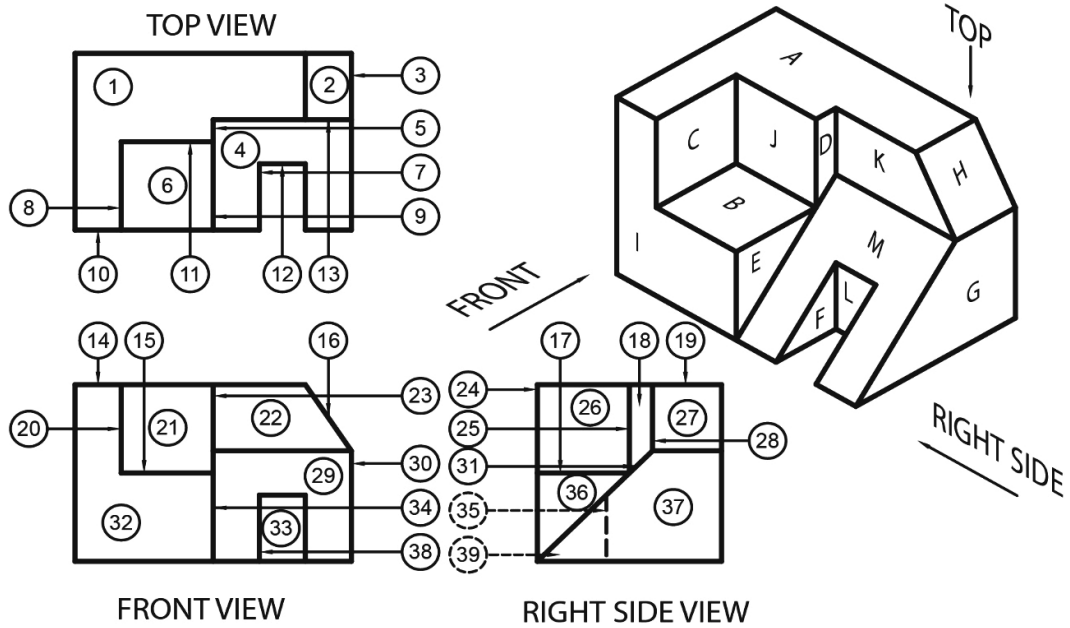


	A	B	C	D	E	F	G
FRONT							
TOP							
RIGHT SIDE							

NOTES:

Name: _____ Date: _____

P2-9) Match the numbers in the orthographic projection with the letters in the pictorial.

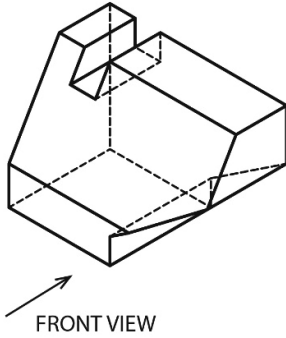


	FRONT	TOP	RIGHT SIDE
A			
B			
C			
D			
E			
F			
G			
H			
I			
J			
K			
L			
M			

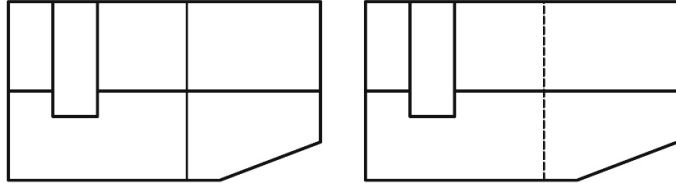
NOTES:

Name: _____ Date: _____

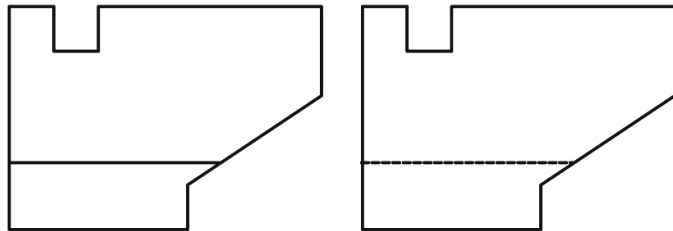
P2-10) Match the object with its correct front, top and right-side views. Note that views should not be aligned on an orthographic projection as shown in this problem.



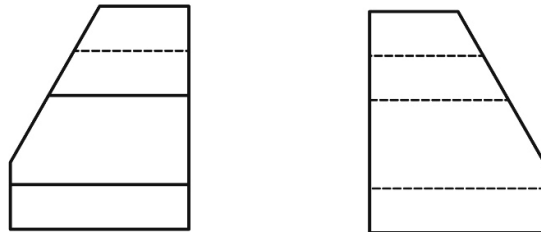
TOP VIEW



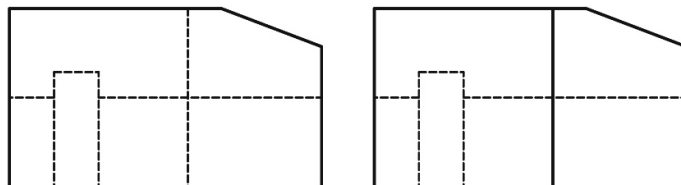
FRONT VIEW



RIGHT SIDE VIEW



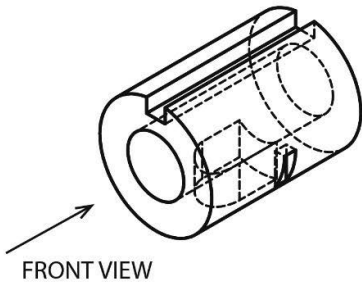
BOTTOM VIEW



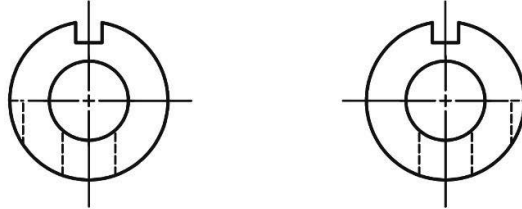
NOTES:

Name: _____ Date: _____

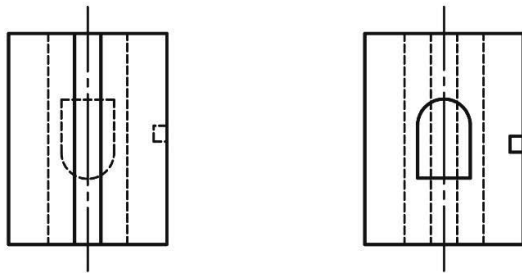
P2-11) Match the object with its correct front, top and right-side views. Note that views should not be aligned on an orthographic projection as shown in this problem.



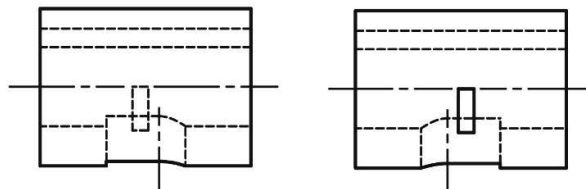
FRONT VIEW



TOP VIEW



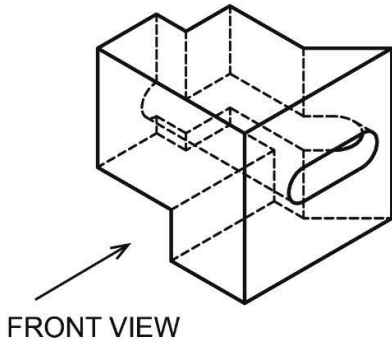
RIGHT SIDE VIEW



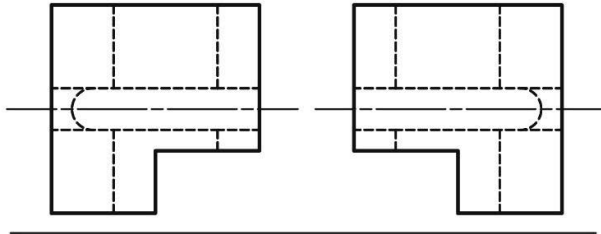
NOTES:

Name: _____ Date: _____

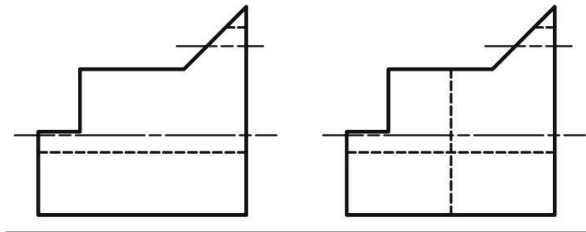
P2-12) Circle the correct front, top and right side views. Note that this problem does not show correct view alignment.



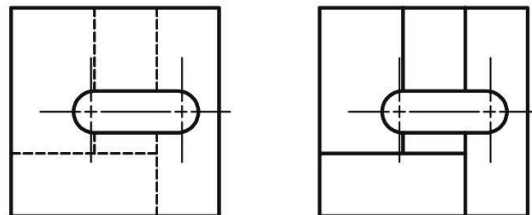
FRONT VIEW



TOP VIEW



RIGHT SIDE VIEW



NOTES: