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# Properties of Orthographic Projection

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**Unit:** Orthographic and Multi-View Projection

**Problem Area:** Orthographic and Multi-View Projections

**Lesson:** Properties of Orthographic Projection

- **Student Learning Objectives.** Instruction in this lesson should result in students achieving the following objectives:

- 1 Identify the principal views used in orthographic projection.**
- 2 Explain primary and secondary views and representations of normal and inclined surfaces.**

- **List of Resources.** The following resources may be useful in teaching this lesson:

Giesecke, Frederick E., et al. *Technical Drawing*, 12th ed. Prentice Hall, 2003.

Spencer, Henry Cecil, John Thomas Dygdon, and James E. Novak. *Basic Technical Drawing*, 8th ed. Glencoe/McGraw-Hill, 2004.

Walker, John R., and Bernard D. Mathis. *Exploring Drafting*. The Goodheart-Wilcox Company, 2007.

Wikipedia. *Orthographic Projection*. Accessed Dec. 20, 2007. <[http://en.wikipedia.org/wiki/Orthographic\\_projection](http://en.wikipedia.org/wiki/Orthographic_projection)>.



## ■ **List of Equipment, Tools, Supplies, and Facilities**

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials

## ■ **Terms.** The following terms are presented in this lesson (shown in bold italics):

- ▶ feature
- ▶ foreshortened
- ▶ frontal plane
- ▶ glass box
- ▶ horizontal plane
- ▶ inclined surface
- ▶ necessary views
- ▶ non-parallel surfaces
- ▶ parallel surfaces
- ▶ primary views
- ▶ principal planes
- ▶ principal views
- ▶ profile plane
- ▶ secondary views

## ■ **Interest Approach.** Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situation. A possible approach is included here.

*“Drawing is putting a line around an idea.” (Henri Matisse, [http://thinkexist.com/quotation/drawing\\_is\\_putting\\_a\\_line-a-round\\_an\\_idea/144598.html](http://thinkexist.com/quotation/drawing_is_putting_a_line-a-round_an_idea/144598.html)) Almost everything in our designed world is drawn or sketched on a drafting table, computer, or napkin. The most common and fundamental approach to technical drawing is to use orthographic projection, a multi-view approach, to display three-dimensional details in two dimensions.*

# SUMMARY OF CONTENT AND TEACHING STRATEGIES

**Objective 1:** Identify the principal views used in orthographic projection.

**Anticipated Problem:** How are three-dimensional objects shown in two dimensions?

## I. Principal views

- A. No single drawing is able to show what an object truly looks like or will look like. With proper training, however, the drafter is able to use multiple two-dimensional drawings to visualize three-dimensional objects. This is accomplished through the use of the six **principal views** to describe an object and illustrate its key features:
1. Front view
  2. Top view
  3. Right side view
  4. Bottom view
  5. Left side view
  6. Rear view
- B. Each of the principal views is aligned in a standard order as if it were hinged around the front view.
1. The top view is located directly above the front view (the front edge of the object becomes the bottom of the top view).
  2. The right side view is directly to the right of the front view (the front edge of the object becomes the left edge of the right side).
  3. The bottom view is located directly below the front view.
  4. The left side view is directly to the left of the front view.
  5. The rear view is to the left of the left side view.
  6. By lining up all the views, several techniques may be employed to transfer details from one view to another.
- C. Creating the six principal views
1. The **glass box** method is one way of creating the six principal views. This method involves visualizing or actually placing items to be drawn inside a clear box. Once the item is in the glass box (literally or figuratively), the drafter then draws the item only as it is visible from each side of the box.
  2. Projection methods rely on the use of projection planes to illustrate key details of an object, utilizing **principal planes** to visualize the object. The principal planes are the frontal plane, the horizontal plane, and the profile plane.
    - a. The **frontal plane** is used to describe front and rear details.

- b. The **horizontal plane** is used to describe an object's top and bottom details.
- c. The **profile plane** is used to describe an object's right and left side details.
- d. All details clearly visible in a given projection plane are transferred to the view without regard for depth of an object. The depth of features or details is established by the other projection planes and is illustrated in the other views.

*Many techniques can be used to help students master this objective. Use a glass or acrylic box to help show the six principal views. If an actual glass box is not available, use VM-A or a cardboard box to illustrate the glass box method. Explain that as an object sits inside the box we can assign the six principal views to it. Use VM-B to illustrate the principal planes and the methods of projection. A piece of glass or clear rigid plastic like acrylic or Plexiglas would also work. Pick a sample object from the room, preferably something geometrically simple with sides primarily in the principal planes (a stack of sticky notes works great), and work through drawing the object on the board. If possible, label the sides of the object and measure them, or have students measure them to apply basic length, width, and depth dimensions. Use LS-A to introduce students to the practice of creating multi-view sketches.*

**Objective 2:** Explain primary and secondary views and representations of normal and inclined surfaces.

**Anticipated Problem:** Why does a skilled drafter need to be able to draw objects that are more complex than simple blocks?

## II. Representing key features

- A. As the drafter transitions from simple block geometry to more complex challenges, the expectations are still the same: All key features of an object need to be shown in all views. A **feature** is any distinguishing characteristic of an object. It could be a straight or curved edge, a hole, a protrusion, or any other shape that makes the object appear as it does.
  - 1. Though all features must be shown in all views, each feature is not always represented in the same way.
    - a. **Primary views** are those principal views in which a feature is shown in its true shape.
    - b. In all other views, the feature is further defined but not in its true shape. These are considered **secondary views**.
    - c. Primary and secondary do not necessarily imply significance or importance; both types of views are equally important in describing the features of an object.
    - d. Consider a hole drilled into a block of wood. The primary view will show the circular nature of the hole, and the secondary view will detail the depth of

the hole or whether it is a round peg protruding from the block. With only secondary views, there is no way to distinguish between a round or square hole.

2. It is essential to understand the concept of orthographic projection and the principal views as early as possible when working with drafting and design problems. In many instances, however, the principal views can be very redundant. Therefore, there are only a few **necessary views**, the minimum views required to fully define an object.
  - a. In approaching a drawing, only the views that are necessary should be included. This often results in drawings with three views.
  - b. In creating a three-view drawing, the front view is the drawing that provides the greatest level of detail and description about an object, and the right (or left) view and top view provide the supporting details to fully describe the object.
- B. As previously mentioned, all features of an object must be shown in all views; however, some features require different approaches. There are two main distinctions between the many different features that need to be shown in any drawing: parallel and non-parallel surfaces.
  1. Up to this point, most of the examples have utilized features that are parallel to one of the three projection planes. Objects that fall into the category of **parallel surfaces** will be shown in true shape and size in a primary view.
  2. Some of the bigger challenges in technical drawing are the features that do not run parallel to any of the projection planes. These are referred to as **non-parallel surfaces**.
    - a. A non-parallel surface, also called an **inclined surface**, does not appear in true shape in any of the principal views, and it is never shown with a primary view.
    - b. The shape of a non-parallel surface is defined by the combination of secondary views, which means the edges of these features are true size in the different views but the feature itself appears **foreshortened** in those views.

*Many techniques can be used to help students master this objective. Use VM–C to illustrate primary and secondary views. Use VM–D to illustrate parallel and non-parallel surfaces.*

- **Review/Summary.** Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the ends of chapters in the textbook may also be used in the review/summary.
- **Application.** Use the included visual masters and lab sheet to apply the information presented in the lesson.

- **Evaluation.** Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided.

- **Answers to Sample Test:**

**Part One: Matching**

1. b
2. a
3. c
4. e
5. d
6. f

**Part Two: Short Answer**

1. front, top, right, left, rear, and bottom
2. Primary views are the principal views in which a feature is shown in its true shape. Secondary views are the principal views that assist in further defining the object's features without showing its true shape.
3. A parallel surface shows an object in its true shape and size in a primary view. A non-parallel surface does not appear in true shape in any of the principal views, and it is never shown with a primary view.

**Part Three: Completion**

1. foreshortened
2. front
3. glass box method
4. true shape and size
5. secondary
6. left

# Properties of Orthographic Projection

## ► Part One: Matching

**Instructions:** Match the term with the correct definition.

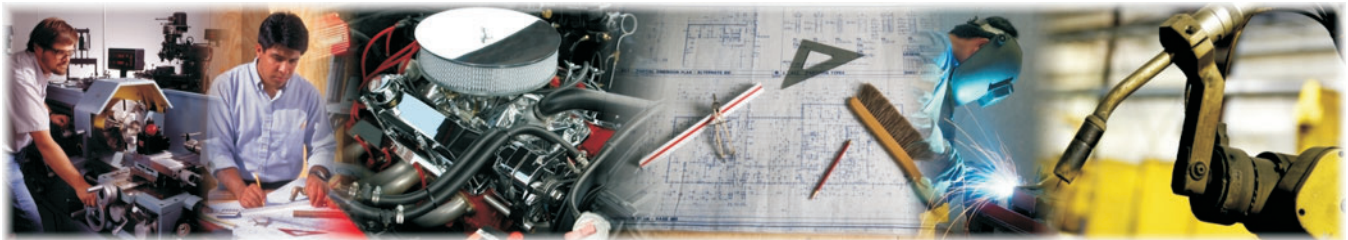
- |                    |                     |
|--------------------|---------------------|
| a. necessary views | d. horizontal plane |
| b. principal views | e. profile plane    |
| c. frontal plane   | f. feature          |

- \_\_\_\_ 1. The six views that illustrate the key features of an object
- \_\_\_\_ 2. The minimum views required to fully define an object
- \_\_\_\_ 3. Used to describe front and rear details
- \_\_\_\_ 4. Used to describe right and left side details
- \_\_\_\_ 5. Used to describe top and bottom details
- \_\_\_\_ 6. Any distinguishing characteristic of an object

## ► Part Two: Short Answer

**Instructions:** Complete the following.

1. List the six principal views.



2. What are primary and secondary views?

3. Distinguish between parallel and non-parallel surfaces.

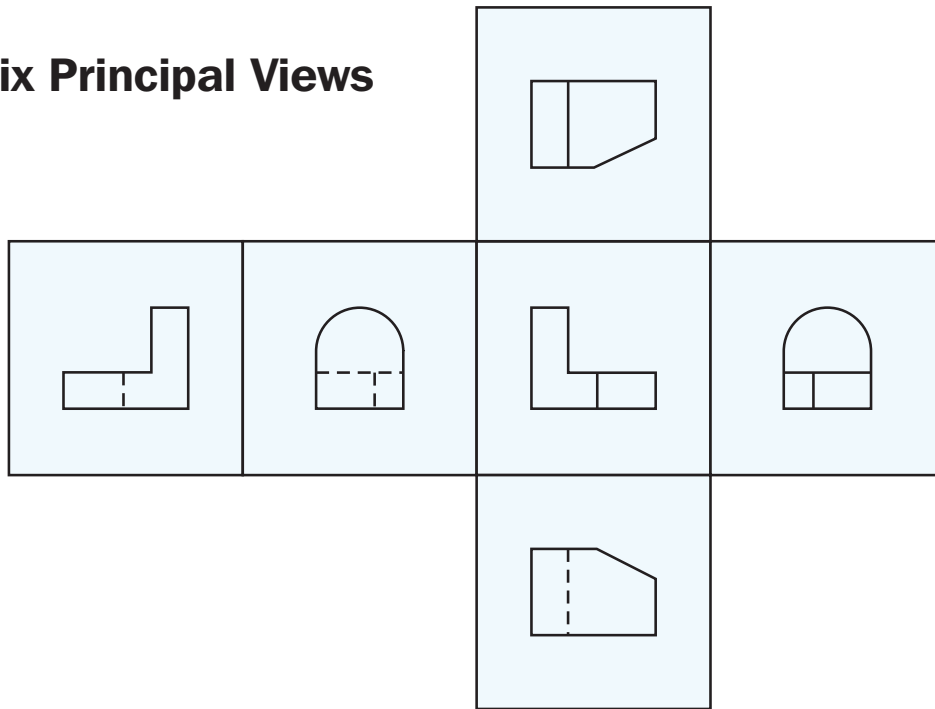
► **Part Three: Completion**

**Instructions:** Provide the word or words to complete the following statements.

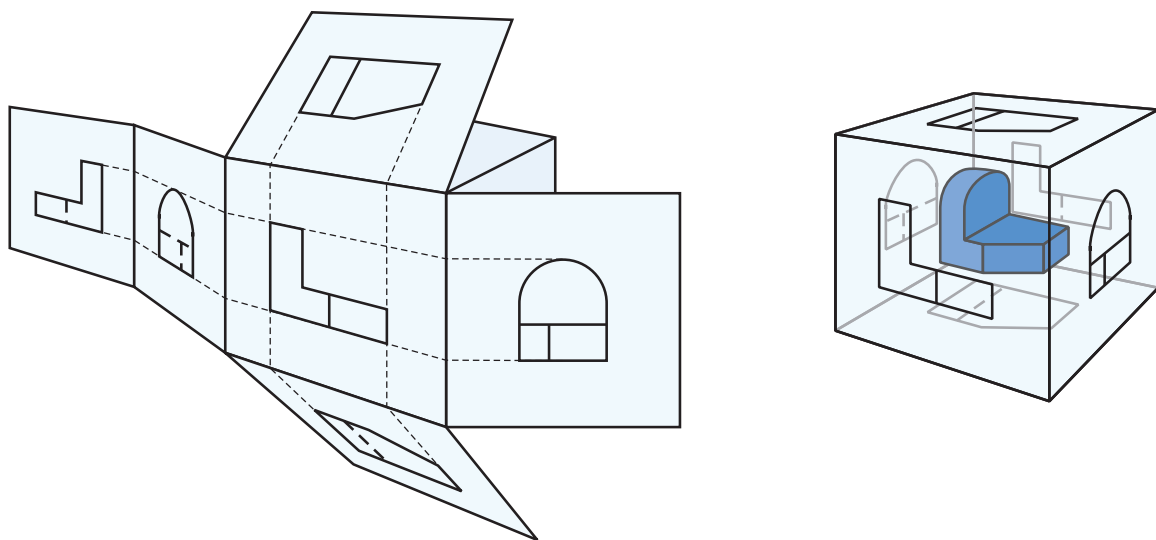
1. An inclined surface appears to be \_\_\_\_\_ in the principal views.
2. The \_\_\_\_\_ view should illustrate the most descriptive details of an object.
3. Picturing an object as if it were inside of a transparent cube is known as the \_\_\_\_\_.
4. When drawing features that are parallel to the principal planes, the features appear in \_\_\_\_\_.
5. Views that help to define a feature but do not illustrate its true shape are called \_\_\_\_\_ views.
6. The rear view is to the \_\_\_\_\_ of the left side view.

# SIX PRINCIPAL VIEWS AND THE GLASS BOX

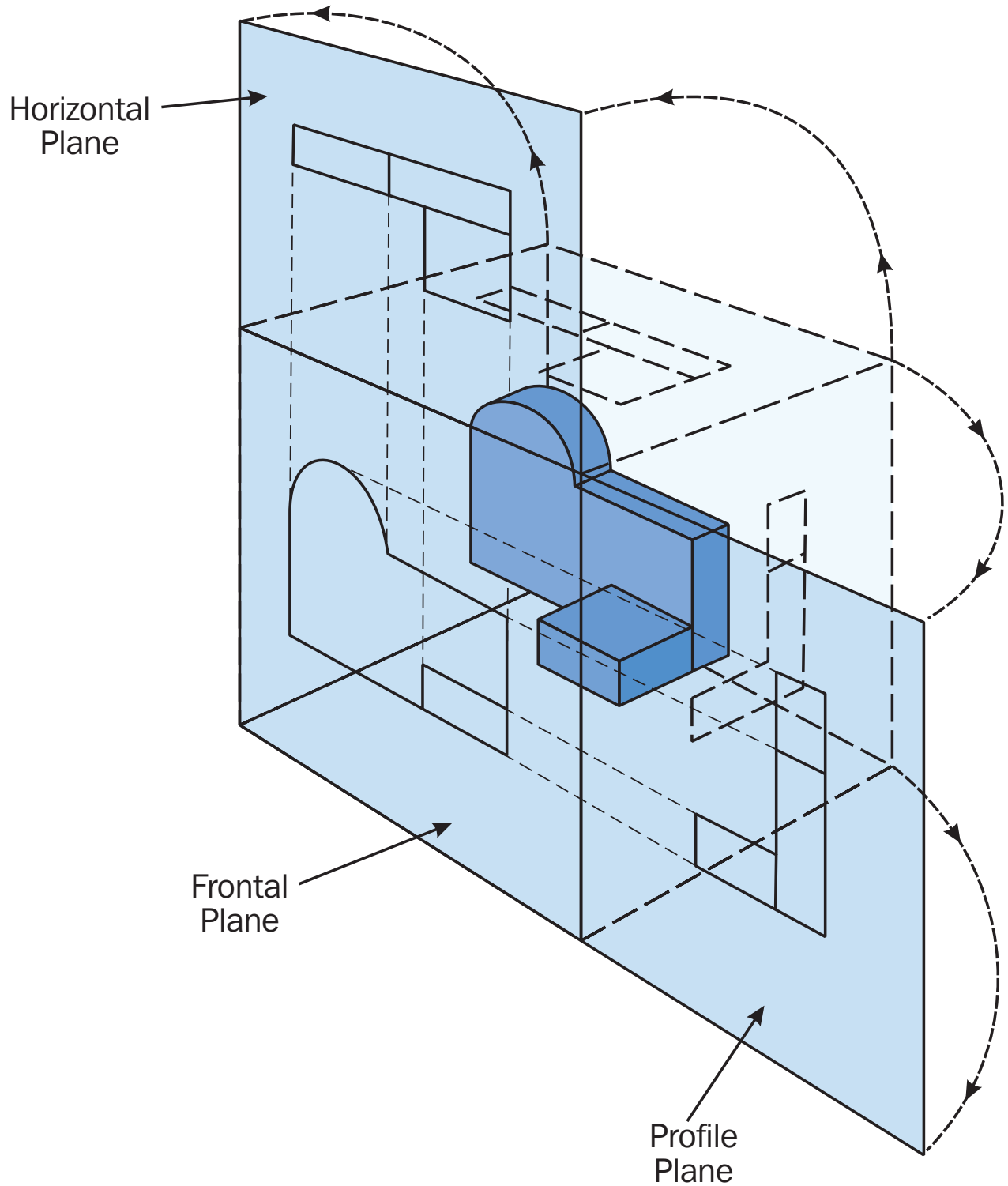
## The Six Principal Views



## The Glass Box Method

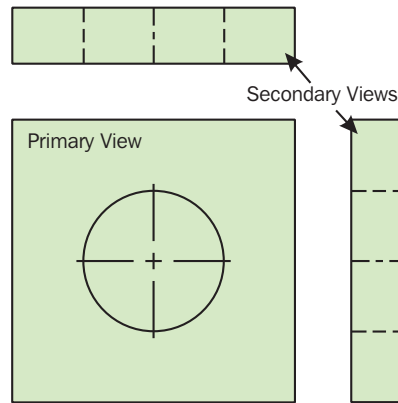


# PLANES OF PROJECTION

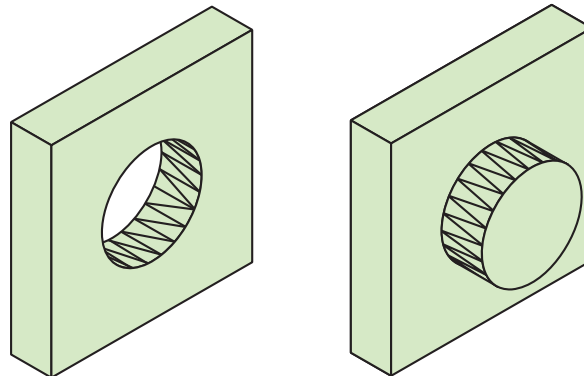


# PRIMARY AND SECONDARY VIEWS TO DEFINE FEATURES

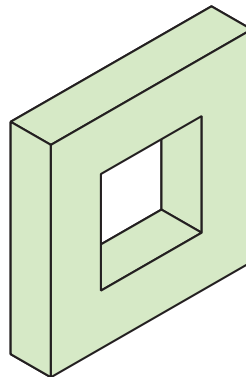
## Primary and Secondary Views



Only having the primary view doesn't reveal the whole picture:

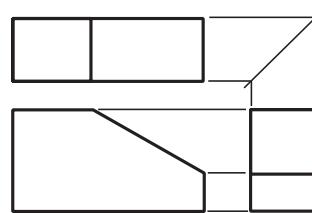
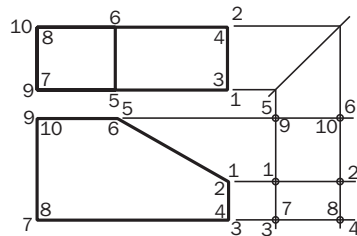
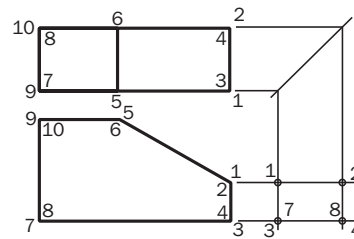
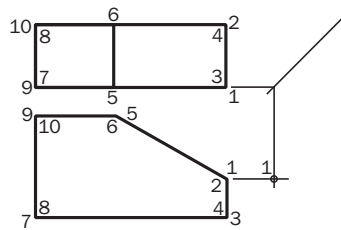
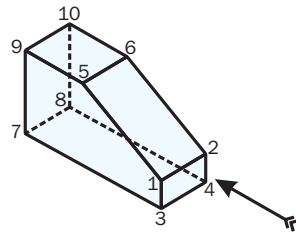


Yet, not having the primary view, the object could be:

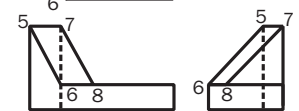
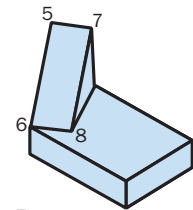
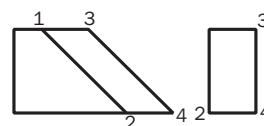
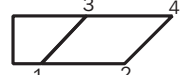
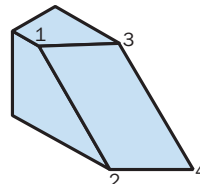
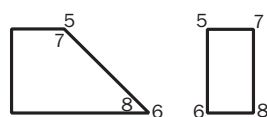
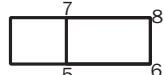
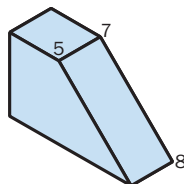
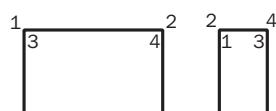
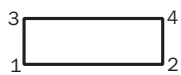
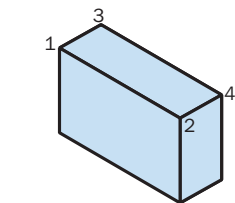


# PARALLEL AND NON-PARALLEL SURFACES

## Images of Parallel and Non-parallel Surfaces



## Foreshortened Items



# Primary and Secondary Views Within the Six Principal Views

## Purpose

The purpose of this activity is to identify the six principal views of orthographic drawing and to label primary and secondary views of different features.

## Objectives

1. Identify the principal views used in orthographic projection.
2. Explain primary and secondary views and representations of normal and inclined surfaces.

## Materials

- ◆ scissors
- ◆ glue
- ◆ different-colored highlighters
- ◆ lab sheet
- ◆ writing utensil

## Procedure

1. Cut out and paste the principal views in the correct orientation based on the supplied front view.
2. Using different-colored highlighters, label the primary views and their secondary counterparts.
3. Write a summary statement of how and why you selected your primary and secondary views.

