

Properties of Multiview Projection

Unit: Orthographic and Multiview Projection

Problem Area: Multiview Projections

Lesson: Properties of Multiview Projection

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

- 1 Identify the primary types of multiview projection.**
- 2 Identify the principal views of an object in first-angle projection and third-angle projection.**
- 3 Create first-angle projection and third-angle projection drawings.**

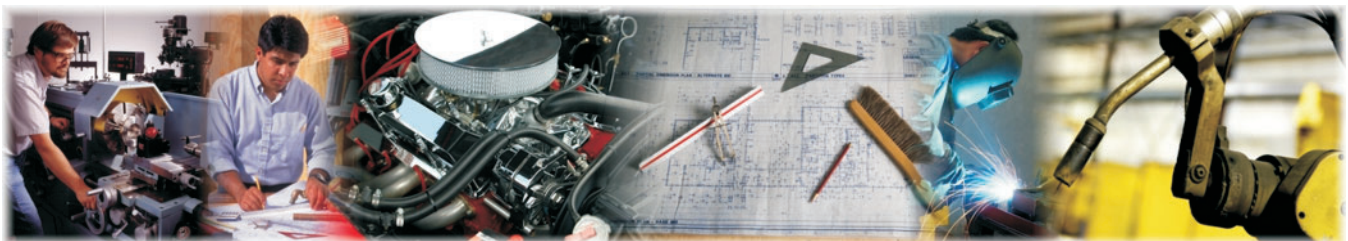
- **List of Resources.** The following resources may be useful in teaching this lesson:

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

Illinois Drafting Educators Association. *I.D.E.A. Curriculum*. Accessed June 18, 2008. <<http://www.idea-online.org/curriculum.html>>.

Madsen, David A. *Engineering Drawing and Design*, 4th ed. Cengage Learning, 2007.

Spencer, Henry, et al. *Basic Technical Drawing*, Glencoe/McGraw-Hill, 2004.



■ **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):

- first-angle projection
- Gaspard Monge
- height
- length
- projection lines
- projection planes
- third-angle projection
- width

■ **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.

Visualizing an object in space is difficult for some students, let alone comprehending the differences between the different types of multiview projection. Ask the students to bring in LEGO® bricks, and discuss which views they consider to be the top, front, and side of the bricks. They will soon realize that points of view differ. Determining the principal views is critical to the pencil or CAD drawing of that object.

Most students in the United States will quickly recognize third-angle projection from many different commonly drawn objects and instructions. Mention that other people can see an object differently and that their points of view are not wrong, just different. Then, explain that engineers and designers in Europe and Asia see things differently than U.S. engineers and designers. As a result, it is extremely important that each angle of projection be cited on a drawing that may be used internationally.

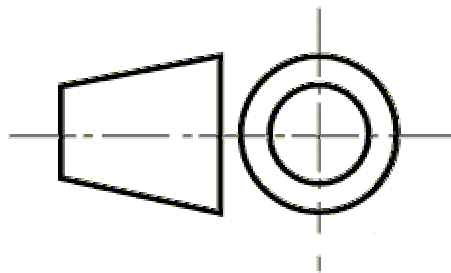
Explain to the students that the design engineer, drafter, or architect follows a set of standards based on his or her country and the measurement scales that are used. All of this is critical information; if the drawing is misunderstood, the part may be produced incorrectly due to the point of view or sizes. Using an Internet connection, refer students to a link that compares first-angle projection and third-angle projection and explains the names “first-angle projection” and “third-angle projection”: http://www.ul.ie/~rynnnet/orthographic_projection_fyp/webpages/third_angle.html.

SUMMARY OF CONTENT AND TEACHING STRATEGIES

Objective 1: Identify the primary types of multiview projection.

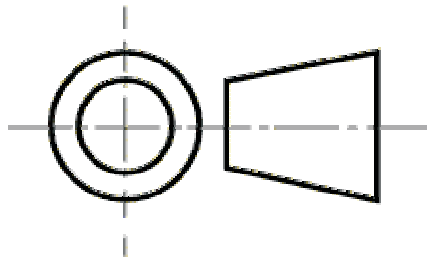
Anticipated Problem: How do you describe the top, front, or side view while visualizing? Why are there two different standards for multiview projection?

- I. A history of different types of multiview projection
 - A. **Gaspard Monge**, the father of descriptive geometry
 1. Monge was a French mathematician.
 2. To illustrate multiview projection, show the following image:
http://en.wikipedia.org/wiki/Image:Gaspard_monge_litho_delpech.jpg
 3. Monge identified the four quadrants of descriptive geometry, and the quadrants are illustrated at http://en.wikipedia.org/wiki/Image:Quadrants_in_descriptive_geometry.png.
 4. Quadrants are defined by two 2D planes intersecting in 3D space.
 - a. A horizontal or ground plane
 - b. A vertical or backdrop plane
 - B. Geometry and quadrants
 1. Rene Descartes and coordinate geometry—To illustrate coordinate geometry, show the following two images: http://en.wikipedia.org/wiki/Image:Cartesian_coordinates_2D.svg and http://en.wikipedia.org/wiki/Image:Frans_Hals_-_Portret_van_Ren%C3%A9_Descartes.jpg.
 2. X, Y, and Z axes
 - C. In **first-angle projection**, views are pushed down or across the object from their surfaces to their projection plane as though they were inside a folded box.



1. First-angle projection is primarily used in Europe and Asia.
2. It is also used by the International Standards Organization (ISO) for metric drawings.

- D. In **third-angle projection**, views are pushed up to the projection plane as though a box was unfolded. Third-angle projection is used primarily in the United States, Canada, and recently in Great Britain.



Use VM–A and VM–B to help students master this objective. Highlight the arrows in each drawing that point in the direction that the view is pushed down or pulled up to the projection plane. Explain that the projection plane is like a “glass box” that surrounds the object as in the illustration. Views are then “projected” up to the glass box or down to the glass box based on which angle of projection is being displayed.

Objective 2: Identify the principal views of an object in first-angle projection and third-angle projection.

Anticipated Problem: In what ways are first-angle projections and third-angle projections similar? In what ways are first-angle projections and third-angle projections different?

II. Unfolding the “glass box”

- A. The “glass box” is a metaphor for the projection planes in multiview projection.
 - 1. First-angle projection pushes the surfaces of the object down and across the object to the projection planes.
 - 2. Third-angle projection pulls the surfaces of the object up to the projection planes.
 - a. First-angle projection is based on the work of the French mathematician Gaspard Monge (the father of descriptive geometry).
 - b. Monge’s work followed up on that of Rene Descartes (the inventor of the Cartesian coordinate system).
- B. The “viewers” point of view
 - 1. In first-angle projection, the viewer unfolds the box from nearest the viewer back away from the viewer.

2. In third-angle projection, the viewer unfolds the box from behind to nearest the viewer.
 - a. The first-angle projection symbol is a truncated cone on its side with concentric circles to the right of it.
 - b. The third-angle projection symbol is a truncated cone on its side with concentric circles to the left of it.
- C. Naming the principal views that are usually shown
 1. Both first angle and third angle have a front view.
 2. First-angle projection has “plan view,” while third-angle projection calls it “top view.”
 3. First-angle projection and third-angle projection have side views, but they are in opposite places.
- D. Identifying other views that are not necessarily shown
 1. Both first-angle projection and third-angle projection have back views and bottom views that may not be shown.
 2. Right side and left side views are on opposite sides when you compare first-angle projection to third-angle projection.
 3. If the right side view is shown, the left side view is usually not necessary; if the left side view is shown, then usually the right side view is not necessary.

Use VM–C. Identify projection lines and projection planes. Then, use VM–D. You may wish to construct a “glass box” from Plexiglas®. Tape the fold line edges together to create hinges. Then, position a model inside the box to demonstrate the projection of surfaces. Explain that projection planes are the imaginary planes that separate each of the principal views of an object. Projection planes are sometimes called fold lines to help identify the front, top, and side views. Tell the students that projection lines are construction lines that help align adjacent views.

Have students sketch the models shown for first-angle and third-angle projection, and compare their sketches to VM–E and VM–F. Have students identify the view names and their positions; then each student should create a sketch with labels for the views and their positions.

Objective 3: Create first-angle projection and third-angle projection drawings.

Anticipated Problem: What is the top view or front view of an object?

III. Creating first-angle projection and third-angle projection

- A. To determine the principal views of an object, the view that should be front or top is based on the object’s orientation.
 1. First-angle projection or third-angle projection starts with the front view in a standard position.

2. In first-angle projection, the plan view is below the front; it is the top view.
 3. In third-angle projection, the top view is above the front view.
- B. It is necessary to determine if the right or left side is the required view.
1. Most often, the right side is the required view.
 2. In first-angle projection, the right side is to the left of the front.
 3. In third-angle projection, the right side is to the right of the front.
- C. It is necessary to visualize the **projection planes** (imaginary planes that separate each of the principal views of an object); these are sometimes called “fold lines” to help identify the front, top, or side views.
- D. Projection lines should be drawn perpendicular to the projection plane from the edges of the principal view.
1. **Projection lines** are construction lines that help align adjacent views.
 2. Projection lines will be erased when the drawing is completed.
- E. The three basic sizes of an object are length, width, and height.
1. **Length** is the longest measurement of an object, usually a horizontal measurement.
 2. **Width** is the shortest horizontal measurement of an object and may be called depth.
 3. **Height** is the vertical measurement of an object.

Use VM–G and then VM–H to help students master this objective. Identify projection lines and projection planes. While drawing with a projection device, have the students do the same at their work areas, labeling each view of the model as they complete it. Have the students complete LS–A and LS–B. Have the students copy the dimensioned first-angle projection and third-angle projection drawings found in LS–C and LS–D.

- **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. Additional drawings that relate to the objectives may be found in the textbooks identified in the Resources section of this lesson plan and the Illinois Drafting Educators Association curriculum at <http://www.idea-online.org/curriculum.html>.
- **Application.** Use the included visual masters and lab sheets 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. d
2. c
3. b
4. e
5. a

Part Two: Short Answer

1. Answers will vary but should encompass the following elements: First-angle projection is the International Standards Organization (ISO) standard for drawings in Europe and Asia. As an increasingly global society, it is important to understand the differences between first-angle projection and third-angle projection for accuracy of drawings.
2. Answers will vary but should include the following: A first-angle projection pushes the surfaces down and across into the projection plane, while a third-angle projection pulls the surfaces up into the projection plane.
3. The three basic sizes of an object are length, width, and height. Length is the longest measurement of an object—usually a horizontal distance. Width is the shortest horizontal measurement of an object and may be called depth. Height is the vertical measurement of an object.

Part Three: Completion

1. perpendicular
2. glass box method
3. plan, front and side
4. top, front and right side

Properties of Multiview Projection

► Part One: Matching

Instructions: Match the term with the correct definition.

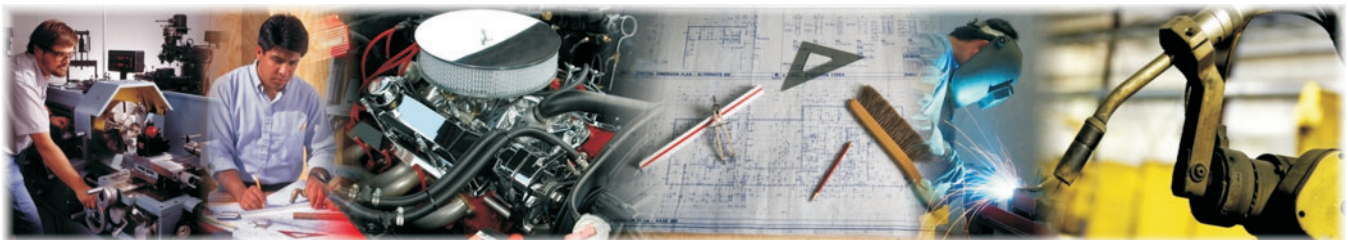
- a. projection lines
- b. projection planes
- c. first-angle projection
- d. Gaspard Monge
- e. third-angle projection

- ____ 1. The father of descriptive geometry
- ____ 2. An ISO standard for metric drawings in Europe and Asia
- ____ 3. These help to identify the front, top, and side views of an object
- ____ 4. These are primarily used in the U.S., Canada, and recently in Great Britain
- ____ 5. These help align adjacent views

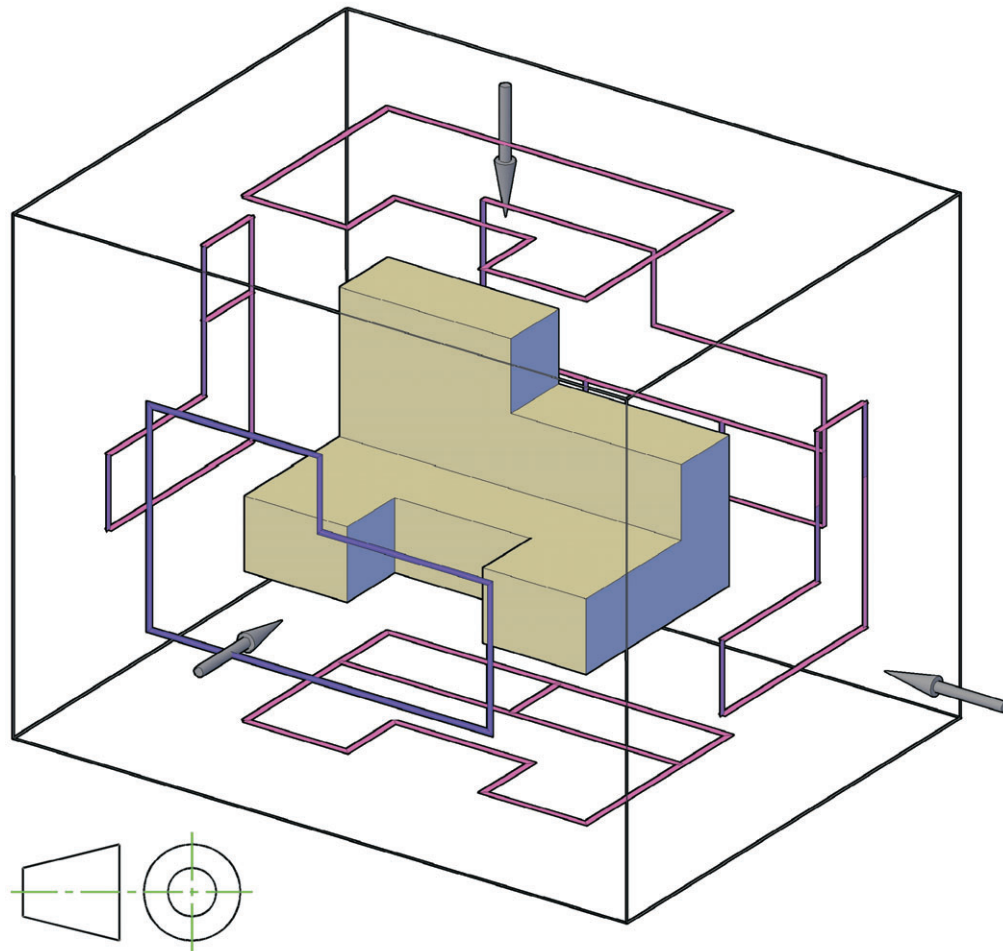
► Part Two: Short Answer

Instructions: Complete the following.

- 1. Explain the importance of first-angle projections to U.S. engineers, drafters, and architects.

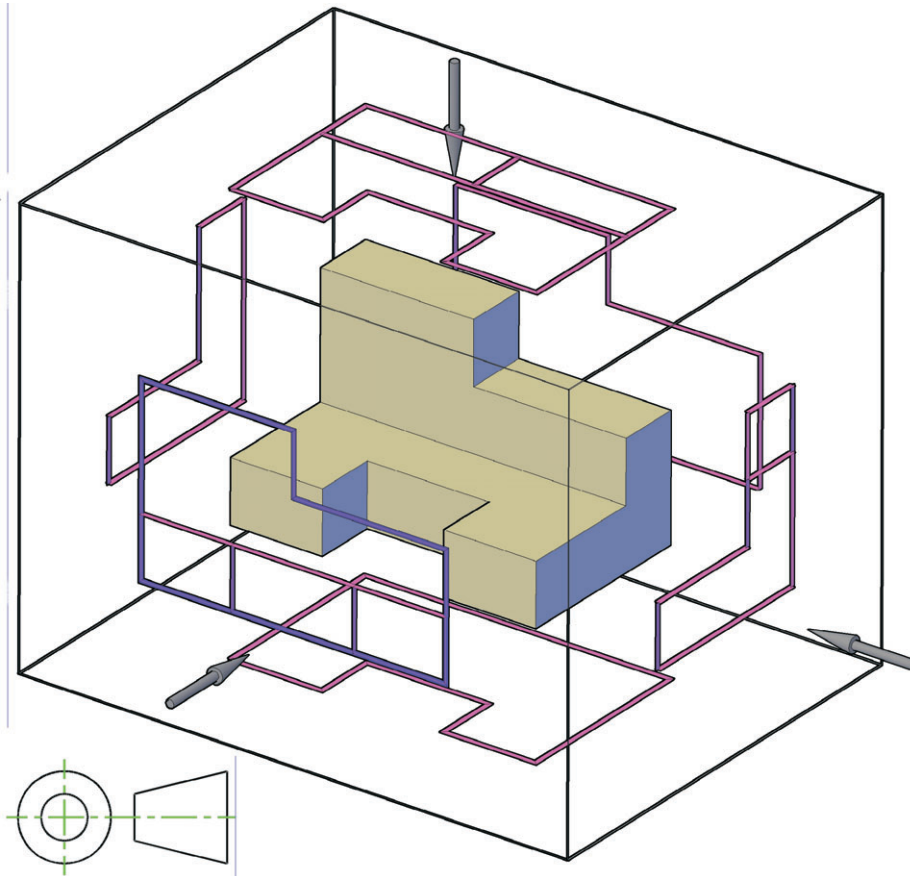


IDENTIFY THE PROPERTIES OF MULTIVIEW PROJECTION: FIRST-ANGLE PROJECTION



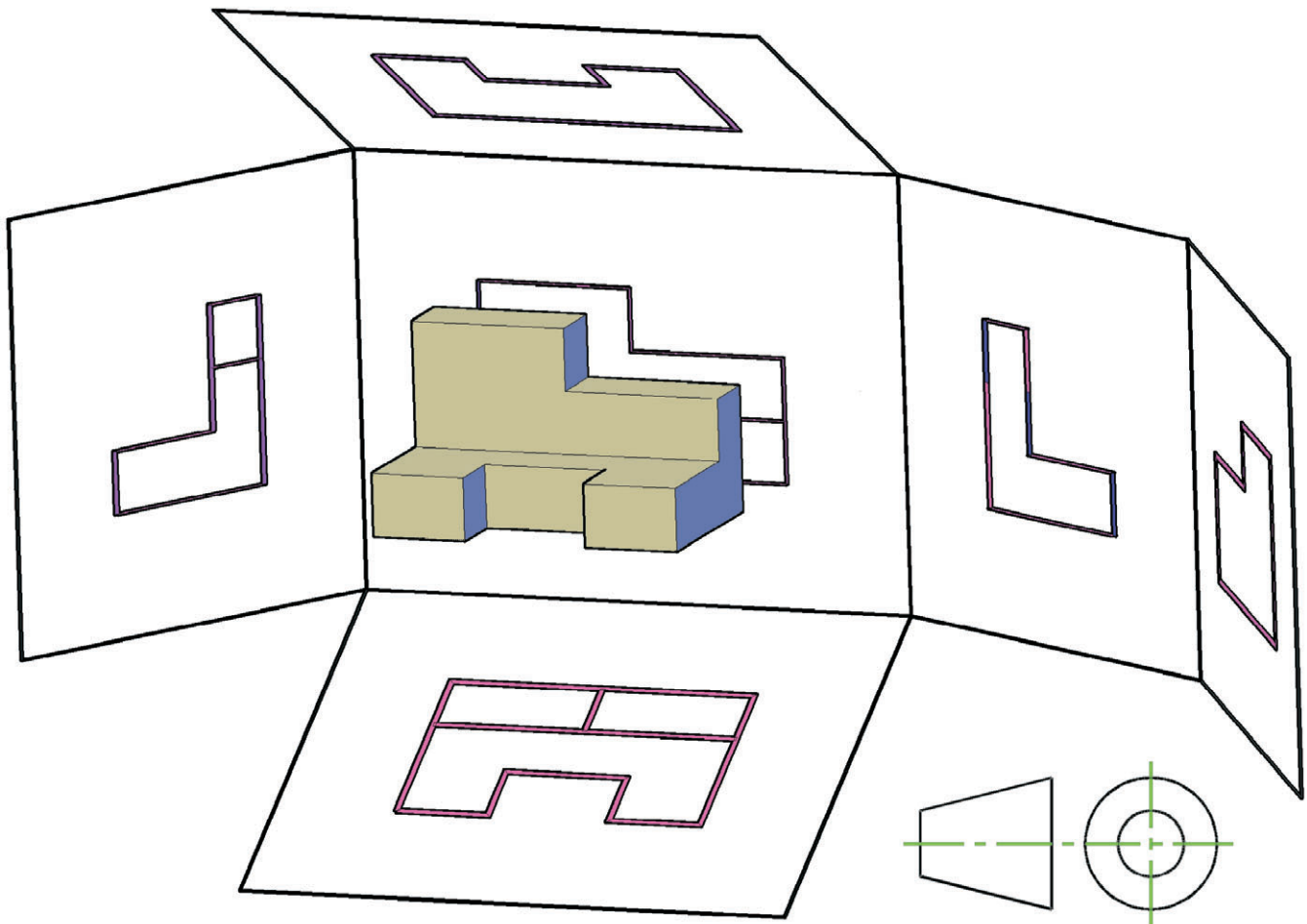
- ◆ All views are pushed down to the projection plane. The arrows indicate the direction of the view of the projection plane. Notice that hidden lines are not shown in this demonstration. To keep the projection clear, dimensions are not shown.
- ◆ It is important that a symbol for first-angle projection be displayed on all projections of this type to eliminate confusion in our global society.

IDENTIFY THE PROPERTIES OF MULTIVIEW PROJECTION: THIRD-ANGLE PROJECTION



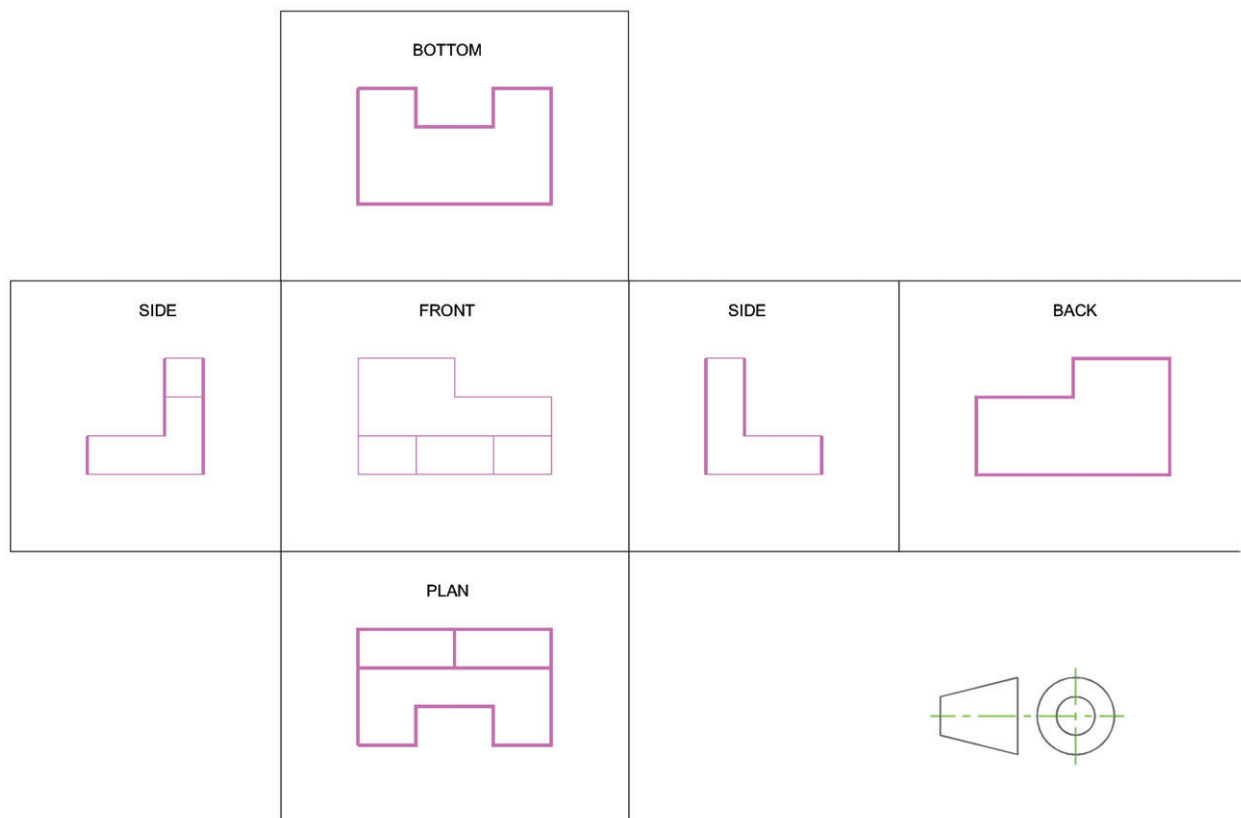
- ◆ All views are pulled up to the projection plane. The arrows indicate the direction of the view of the projection plane. Notice that hidden lines are not shown in this demonstration. To keep the projection clear, dimensions are not shown.
- ◆ Third-angle projection is the standard method of projection in the United Kingdom.
- ◆ It is important that a symbol for third-angle projection be displayed on all projections of this type to eliminate confusion in our global society.

IDENTIFY THE PROPERTIES OF MULTIVIEW PROJECTION: FIRST-ANGLE PROJECTION STARTING TO UNFOLD THE GLASS BOX



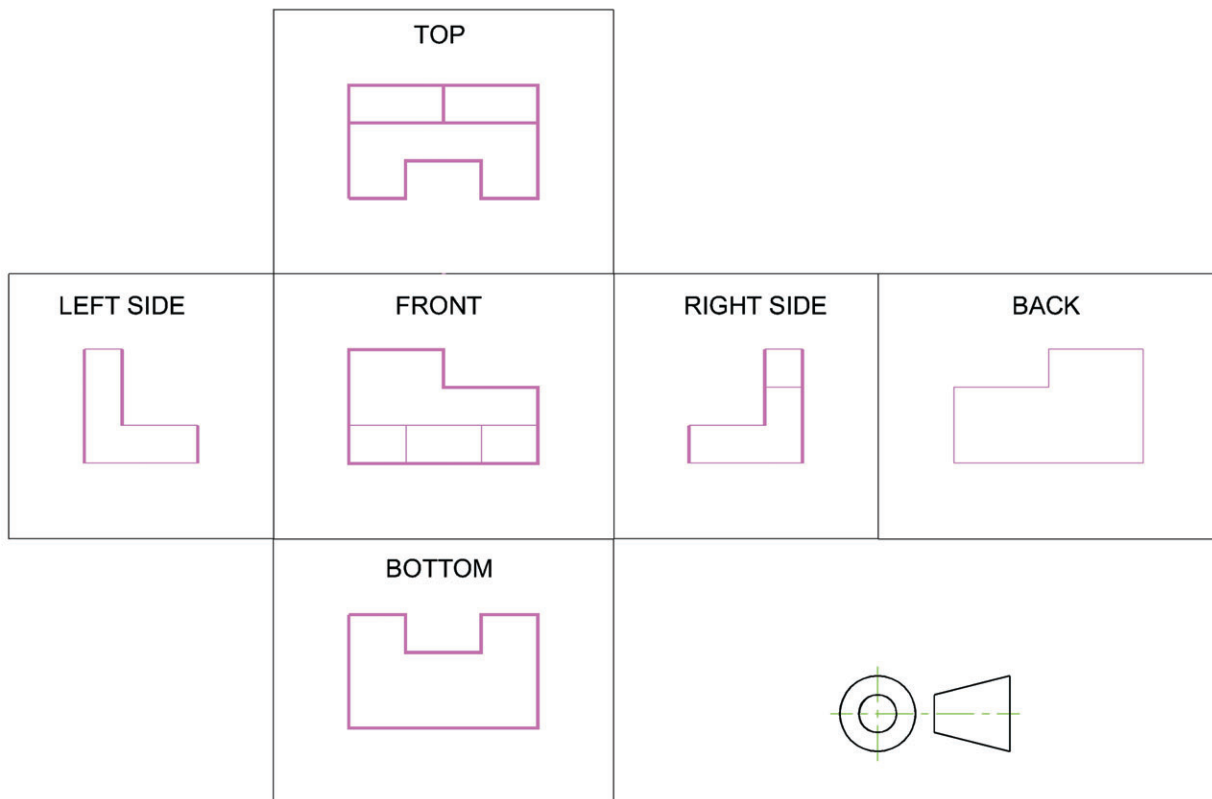
- ◆ Note that the object is floating in space. The projection planes fold up from behind the object in this point of view. The top view folds up from the front view; the left side folds out from the front; the right side folds out from the front; the back folds out from the right side; and the bottom folds down from the front.

IDENTIFY THE PROPERTIES OF MULTIVIEW PROJECTION: FIRST-ANGLE PROJECTION, THE GLASS BOX UNFOLDED



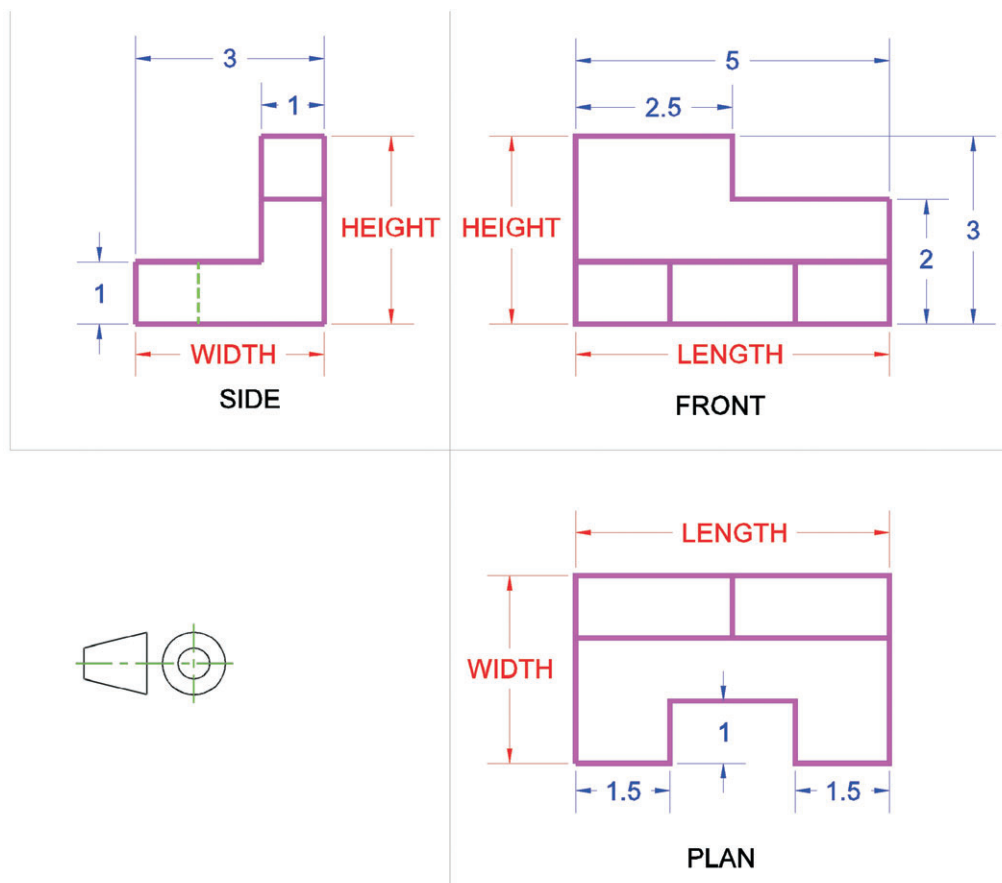
- ◆ All views are pushed down to the projection plane. The arrows indicate the direction of the view of the projection plane. Notice that hidden lines are not shown in this demonstration. To keep the projection clear, dimensions are not shown.
- ◆ First-angle projection is the standard method of projection in Europe and Asia. It was common in the United Kingdom before World War II.
- ◆ It is important that a symbol for first-angle projection be displayed on all projections of this type to eliminate confusion in our global society.

IDENTIFY THE PROPERTIES OF MULTIVIEW PROJECTION: THIRD-ANGLE PROJECTION, THE GLASS BOX UNFOLDED



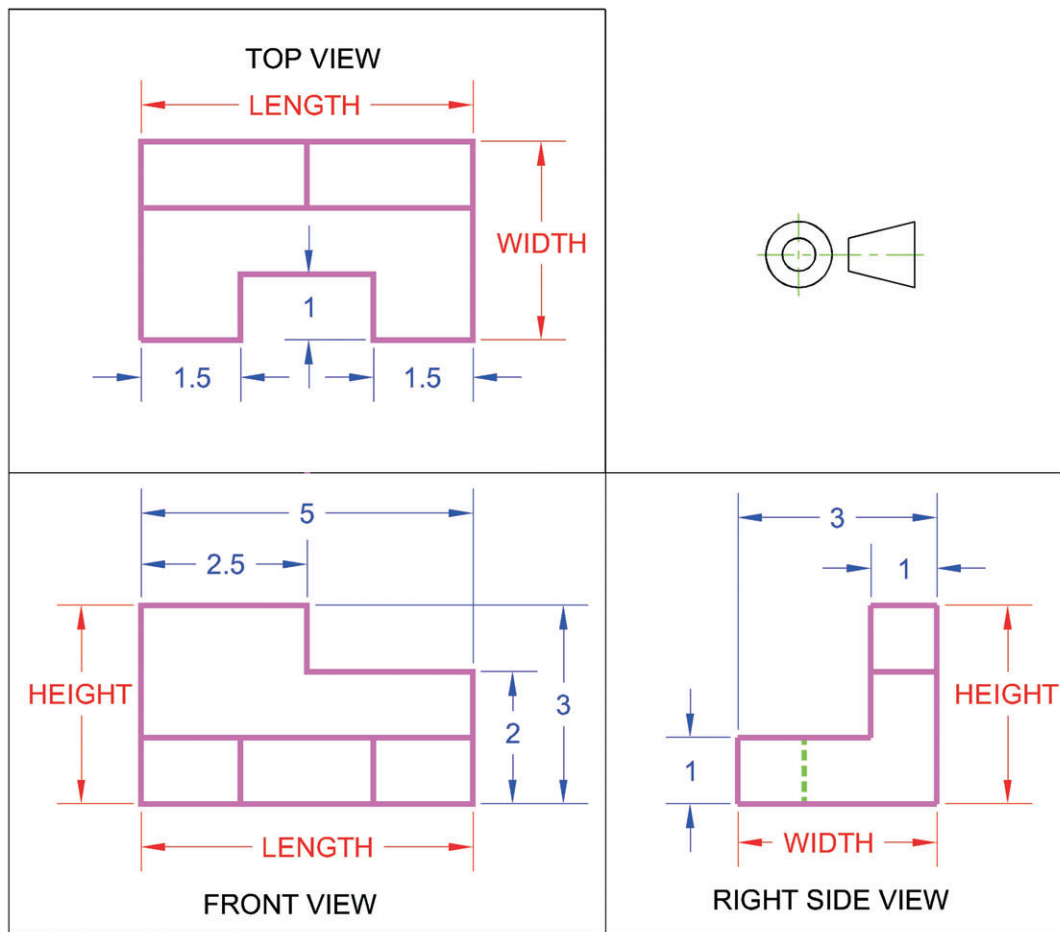
- ◆ All views are pulled up to the projection plane. The arrows indicate the direction of the view of the projection plane. Notice that hidden lines are not shown in this demonstration. To keep the projection clear, dimensions are not shown.
- ◆ Third-angle projection is the standard method of projection in the United States, Canada, and the United Kingdom.
- ◆ It is important that a symbol for third-angle projection be displayed on all projections of this type to eliminate confusion in our global society.

IDENTIFY THE PROPERTIES OF MULTIVIEW PROJECTION: FIRST-ANGLE PROJECTION PRINCIPAL VIEWS



- ◆ Only the principal views are shown in this typical first-angle projection. The plan view is shown below the front, and the side view is shown to the left of the front view. Notice that object lines are shown in magenta, hidden lines in green, and the thick black lines indicate the fold lines from the projection planes. The necessary dimensions are blue, and they are shown in their proper positions. Basic size dimensions are shown in red.

IDENTIFY THE PROPERTIES OF MULTIVIEW PROJECTION: THIRD-ANGLE PROJECTION PRINCIPAL VIEWS



- ◆ Only the principal views are shown in this typical third-angle projection. The top is over the front, and the right side is shown to the right of the front. Notice that object lines are shown in magenta. Hidden lines are shown in green, and the thin black lines indicate fold lines from the projection planes. The necessary dimensions are blue and are shown in their proper positions. Basic dimensions are shown in red.

Identify the Properties of Multiview Projection: First-Angle Projection Matching

Purpose

The purpose of this activity is to match the names of the basic sizes and view names with two-dimensional drawings that represent those conditions.

Objectives

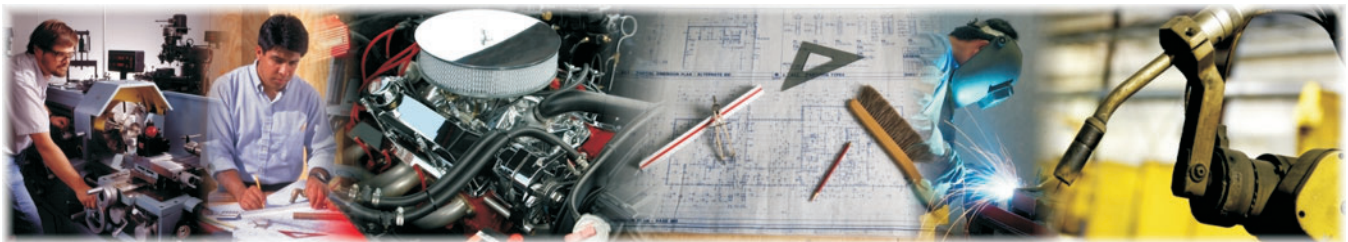
1. Identify the basic sizes of an object.
2. Identify the basic views of an object.

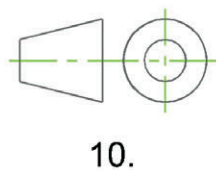
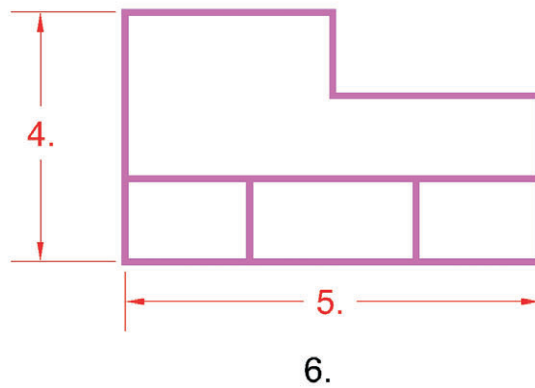
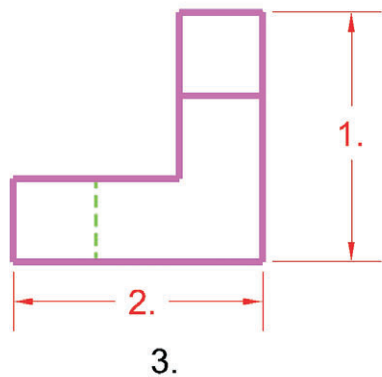
Materials

- ◆ lab sheet
- ◆ writing utensil

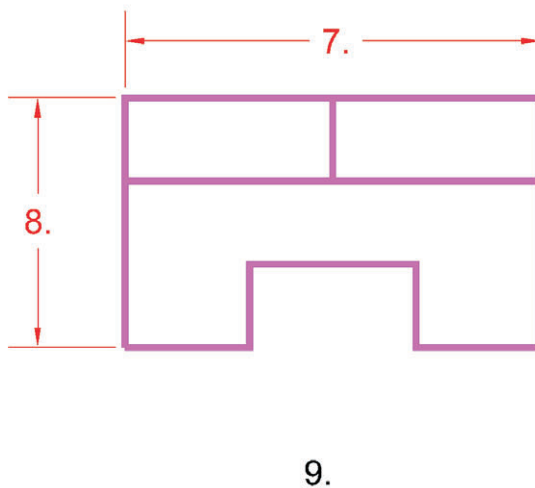
Procedure

Match the number on the object with the letter of the term that describes it. Black numbers are principal views of the object. Red numbers are basic sizes. Note that some terms are used more than once.





- A. Length
- B. Width
- C. Height
- D. Front
- E. Plan
- F. Side
- G. First-angle projection



Identify the Properties of Multiview Projection: First-Angle Projection Matching

1. c
2. b
3. f
4. c
5. a
6. d
7. a
8. b
9. f
10. g

Identify the Properties of Multiview Projection: Third-Angle Projection Matching

Purpose

The purpose of this activity is to match the names of the basic sizes and to view the names with two-dimensional drawings that represent those conditions.

Objectives

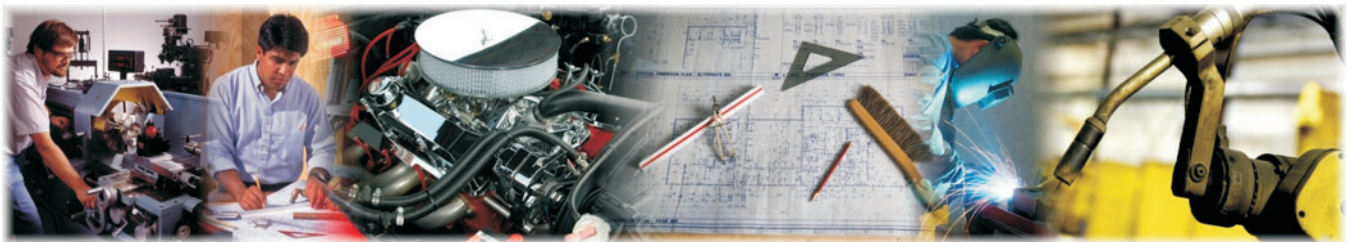
1. Identify the basic sizes of an object.
2. Identify the basic views of an object.

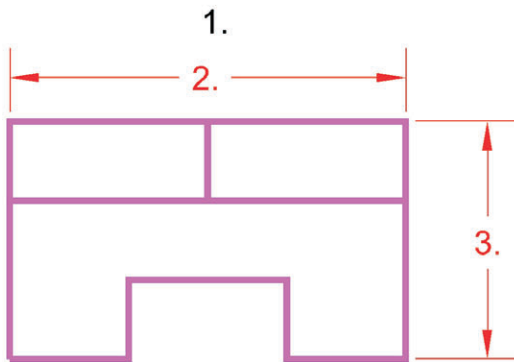
Materials

- ◆ lab sheet
- ◆ writing utensil

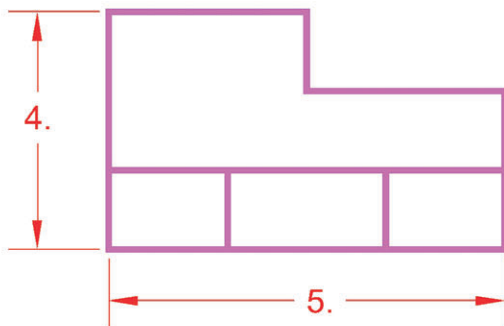
Procedure

Match the number on the object with the term that describes it. Black numbers are principal views of the object. Red numbers are basic sizes. Note that some terms are used more than once.

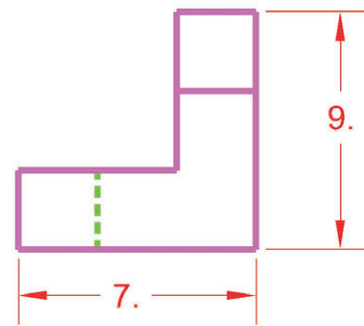
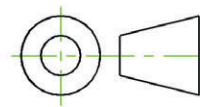




- A. Length
- B. Width
- C. Height
- D. Top view
- E. Front view
- F. Right side view
- G. Third-angle projection



6.



8.

Identify the Properties of Multiview Projection: Third-Angle Projection Matching

1. e
2. a
3. b
4. c
5. a
6. d
7. b
8. f
9. c
10. g

Create a Copy of a First-Angle Projection Drawing

Purpose

The purpose of this activity is to create an accurate first-angle multiview projection drawing.

Objectives

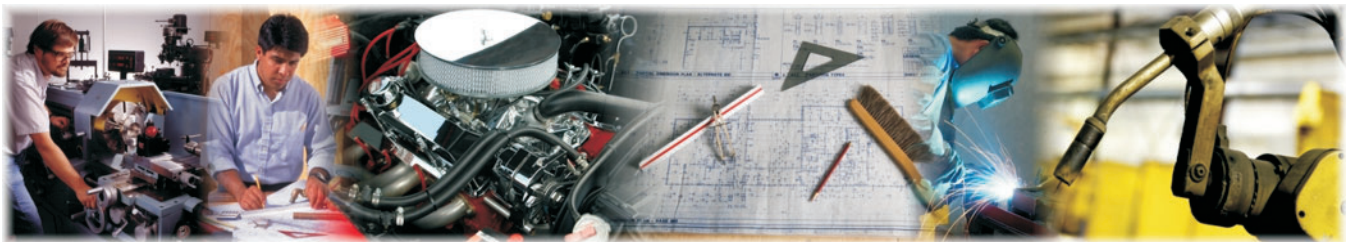
1. Identify the principal views of an object.
2. Use proper drawing technique to size and position the views of an object.

Materials

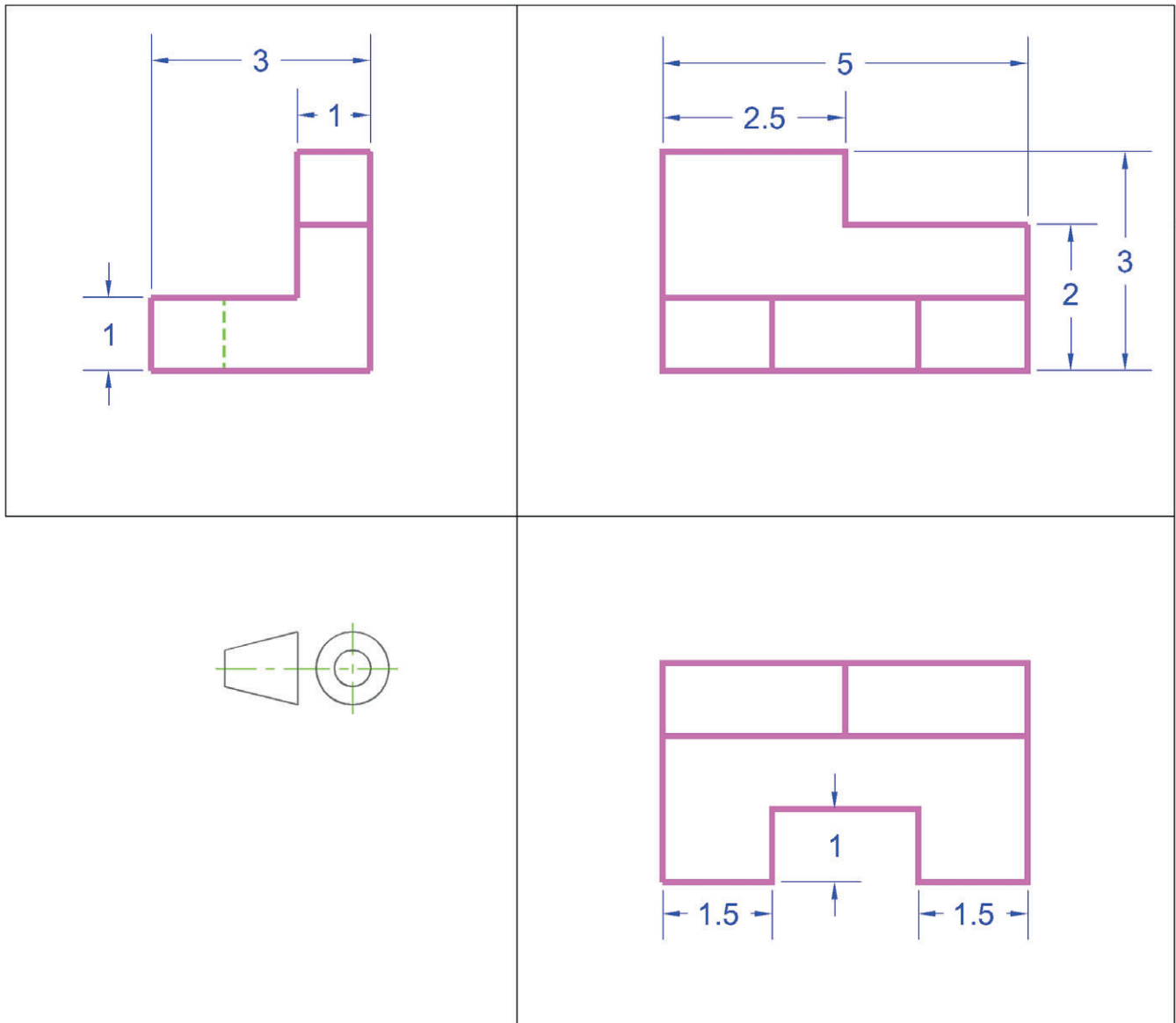
- ◆ lab sheet
- ◆ drawing paper
- ◆ writing utensil

Procedure

1. Create a copy of this first-angle projection drawing.
2. Equally space and center the views.
3. Do not draw the projection plan lines.
4. If you are using a CAD system, change the object lines to black, dimensioning to red, and hidden lines to yellow. Use the same full size decimal inch measurements, but convert them to millimeters. Create the first-angle projection symbol.
5. If you are pencil drafting, use your standard techniques.
6. Lay out construction lines to position views.



7. Measure distances accurately.
8. Complete the necessary views.
9. Darken object lines, and erase construction lines.
10. Add dimensions and a title block as required by your teacher.



Create a Copy of a Third Angle Projection Drawing

Purpose

The purpose of this activity is to create an accurate third-angle multiview projection drawing.

Objectives

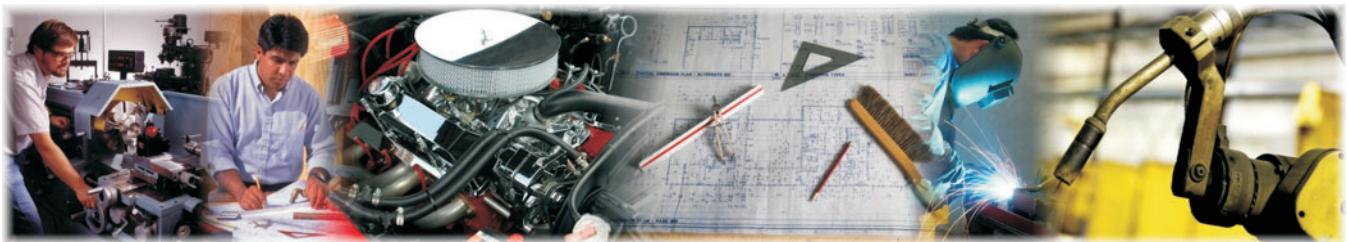
1. Identify the principal views of an object.
2. Use proper drawing technique to size and position the views of an object.

Materials

- ◆ lab sheet
- ◆ drawing paper
- ◆ writing utensil

Procedure

1. Create a copy of this third-angle projection drawing.
2. Equally space and center the views.
3. Do not draw the projection plan lines.
4. If you are using a CAD system, change the object lines to black, dimensioning to red, and hidden lines to yellow. Use the same full size measurements, and create the third angle projection symbol.
5. If you are pencil drafting, use your standard techniques.
6. Lay out construction lines to position views.



7. Measure distances accurately.
8. Complete the necessary views.
9. Darken object lines, and erase construction lines.
10. Add dimensions and a title block as required by your teacher.

