

Chapter 21

Isometric Drawing

Learning Objectives

After completing this chapter you will be able to:

- Understand isometric drawings, isometric axes, and isometric planes.
- Set isometric grid and snap.
- Draw isometric circles in different isoplanes.
- Dimension isometric objects.
- Place text in an isometric drawing.

ISOMETRIC DRAWINGS

Isometric drawings are generally used to help visualize the shape of an object. For example, if you are given the orthographic views of an object (Figure 21-1), it takes time to put information together to visualize the shape. However, if an isometric drawing is given (Figure 21-2), it is much easier to conceive the shape of the object. Thus, isometric drawings are widely used in industry to help in understanding products and their features.

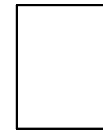
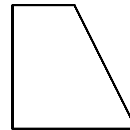
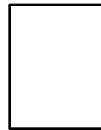
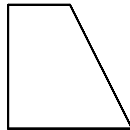
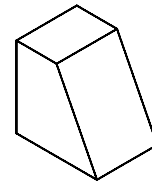
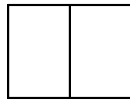


Figure 21-1 Orthographic views of an object

Figure 21-2 Orthographic views with isometric drawing

An isometric drawing should not be confused with a three-dimensional (3D) drawing. An isometric drawing is just a two-dimensional (2D) representation of a 3D drawing in a 2D plane. A 3D drawing is a 3D model of an object on the X, Y, and Z axes. An isometric drawing is a 2D drawing on a 2D plane. A 3D drawing is a true 3D model of the object. The model can be rotated and viewed from any direction. A 3D model can be a wireframe model, surface model, or solid model.

ISOMETRIC PROJECTIONS

The word isometric means “**equal measure**” because the three angles between the three principal axes of an isometric drawing are each 120-degree (Figure 21-3). An isometric view is obtained by rotating the object 45-degrees around the imaginary vertical axis, and then tilting the object forward through a 35°16' angle. If you project the points and the edges on the frontal plane, the projected length of the edges will be approximately 81 percent (isometric length/actual length = 9/11), which is shorter than the actual length of the edges. However, isometric drawings are always drawn to full scale because their purpose is to help the user visualize the shape of the object.

Isometric drawings are not meant to describe the actual size of the object. The actual

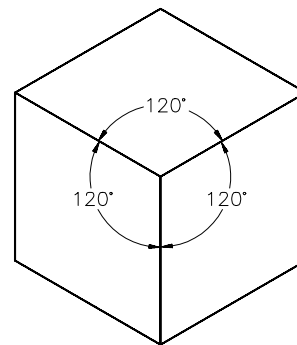


Figure 21-3 Principal axes of an isometric drawing

dimensions, tolerances, and feature symbols must be shown in the orthographic views. Also, you should avoid showing any hidden lines in the isometric drawings, unless they show an important feature of the object or help in understanding the shape of the object.

ISOMETRIC AXES AND PLANES

Isometric drawings have three axes: **right horizontal axis** (P0,P1), **vertical axis** (P0,P2), and **left horizontal axis** (P0,P3). The two horizontal axes are inclined at 30-degree to the horizontal, or *X* axis (X1,X2). The vertical axis is at 90-degrees (Figure 21-4).

When you draw an isometric drawing, the horizontal object lines are drawn along or parallel to the horizontal axis. Similarly, the vertical lines are drawn along or parallel to the vertical axis. For example, if you want to make an isometric drawing of a rectangular block, the vertical edges of the block are drawn parallel to the vertical axis. The horizontal edges on the right side of the block are drawn parallel to the right horizontal axis (P0,P1), and the horizontal edges on the left side of the block are drawn parallel to the left horizontal axis (P0,P3). It is important to remember that the **angles do not appear true** in isometric drawings. Therefore, the edges or surfaces that are at an angle are drawn by locating the endpoints of the edges. The lines that are parallel to the isometric axes are called **isometric lines**. The lines that are not parallel to the isometric axes are called **nonisometric lines**.

Similarly, the planes can be **isometric planes** or **nonisometric planes**.

Isometric drawings have three principal planes, **isoplane right**, **isoplane top**, and **isoplane left**, as shown in Figure 21-5. The isoplane right (P0,P4,P10,P6) is defined by the vertical axis and the right horizontal axis. The isoplane top (P6,P10,P9,P7) is defined by the right and left horizontal axes. Similarly, the isoplane left (P0,P6,P7,P8) is defined by the vertical axis and the left horizontal axis.

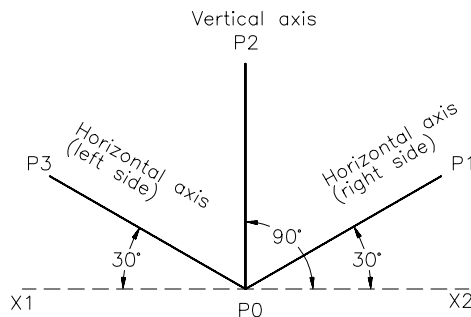


Figure 21-4 Isometric axes

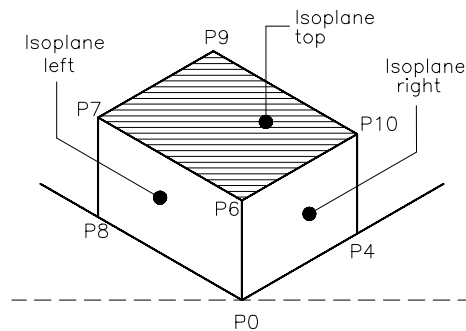


Figure 21-5 Isometric planes

SETTING THE ISOMETRIC GRID AND SNAP

You can use the **SNAP** command to set the isometric grid and snap. The isometric grid lines are displayed at 30-degree to the horizontal axis. Also, the distance between the grid lines is

determined by the vertical spacing, which can be specified by using the **GRID** or **SNAP** command. The grid lines coincide with the three isometric axes, which makes it easier to create isometric drawings. The following command sequence illustrates the use of the **SNAP** command to set the isometric grid and snap of 0.5 units (Figure 21-6).

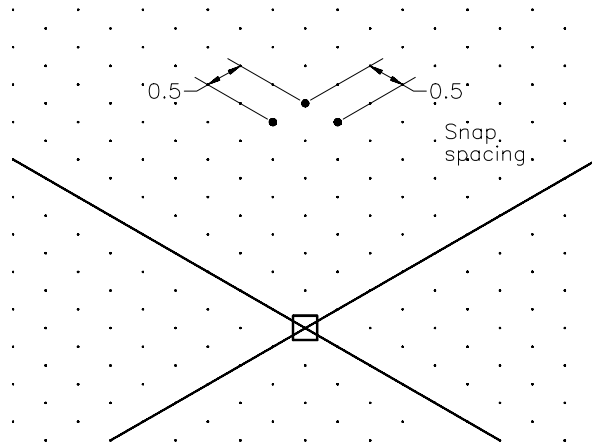


Figure 21-6 Setting isometric grid and snap

Command: **SNAP**

Specify snap spacing or [ON/OFF/Aspect/Rotate/Style/Type] <0.5000>: **S**

Enter snap grid style [Standard/Isometric] <S>: **I**

Specify vertical spacing <0.5000>: Enter new snap distance.



Note

When you use the **SNAP** command to set the isometric grid, the grid lines may not be displayed. To display the grid lines, turn the grid on using the **GRID** command or press F7.

You cannot set the aspect ratio for the isometric grid. Therefore, the spacing between the isometric grid lines will be the same.

You can also set the isometric grid and snap by using the **Drafting Settings** dialog box (Figure 21-7), which can be invoked by entering **DSETTINGS** at the Command prompt.

You can also invoke this dialog box by choosing **Drafting Settings** from the **Tools** menu. The other method to invoke this dialog box is by right-clicking **Snap**, **Grid**, **Polar**, or **Osnap**, on the status bar and choosing **Settings** from the shortcut menu.

The isometric snap and grid can be turned on/off by choosing the **On** box located in the **Snap and Grid/Object Snap** tabs of the **Drafting Settings** dialog box. The **Snap and Grid** tab also contains the radio buttons to set the snap type and style. To display the grid on the screen, make sure the grid is turned on.

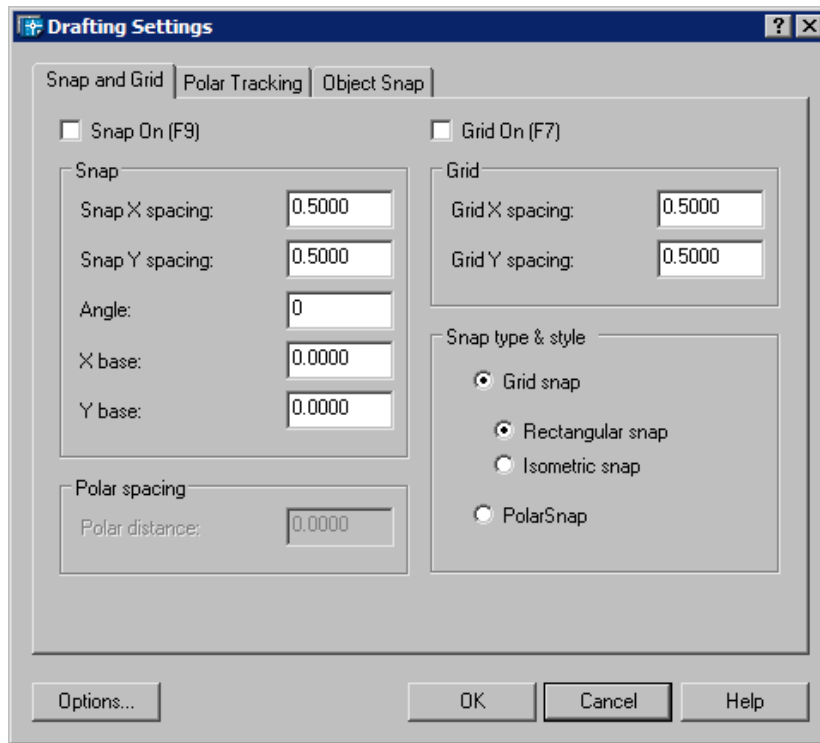


Figure 21-7 Drafting Settings dialog box

When you set the isometric grid, the display of the crosshairs also changes. The crosshairs are displayed at an isometric angle, and their orientation depends on the current isoplane. You can toggle among isoplane right, isoplane left, and isoplane top by pressing the CTRL and E keys simultaneously (CTRL+E) or using the function key F5. You can also toggle among different isoplanes by using the **Drafting Settings** dialog box or by entering the **ISOPLANE** command at the Command prompt:

Command line: **ISOPLANE**

Enter isometric plane setting [Left/Top/Right] <Top>: **T**

Current Isoplane: **Top**

The Ortho mode is often useful when drawing in Isometric mode. In Isometric mode, Ortho aligns with the axes of the current isoplane.

Example 1

Mechanical

In this example, you will create the isometric drawing shown in Figure 21-8.

1. Use the **SNAP** command to set the isometric grid and snap. The snap value is 0.5 units.



Specify vertical spacing <0.5000>: **0.5** (or press ENTER.)

-

Figure 21-9 *Drawing the bottom left face*

3. Change the isoplane to isoplane right by pressing the F5 key. Invoke the **L**INE command and draw the lines as shown in Figure 21-10.

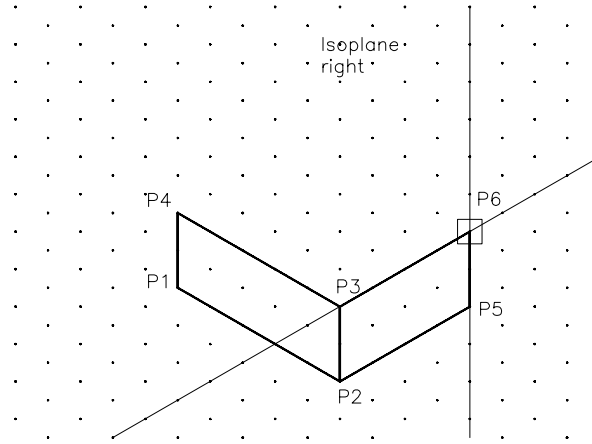


Figure 21-10 Drawing the bottom right face

4. Change the isoplane to isoplane top by pressing the F5 key. Invoke the **LINE** command and draw the lines as shown in Figure 21-11.

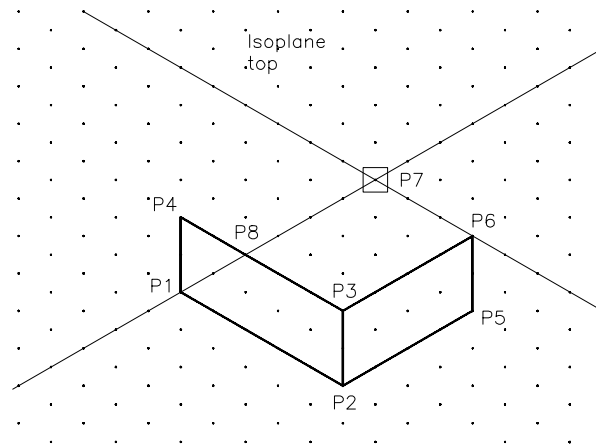


Figure 21-11 Drawing the top face



Tip

You can increase the size of the crosshairs using the **Crosshair size** slider bar in the **Display** tab of the **Options** dialog box.

5. Similarly, draw the remaining lines as shown in Figure 21-12.

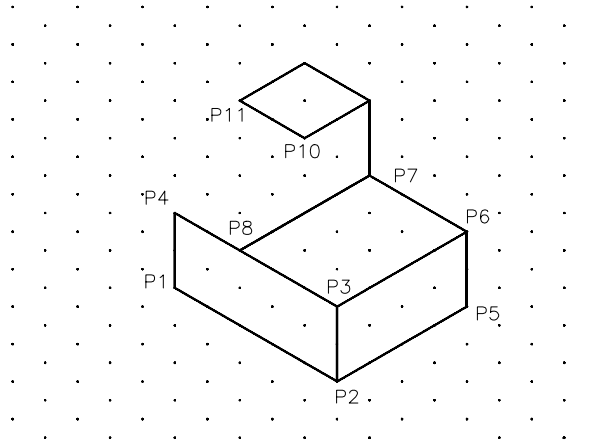


Figure 21-12 Drawing the remaining lines

6. The front left end of the object is tapered at an angle. In isometric drawings, oblique surfaces (surfaces at an angle to the isometric axis) cannot be drawn like other lines. You must first locate the endpoints of the lines that define the oblique surface and then draw lines between those points. To complete the drawing shown Figure 21-8, draw a line from P10 to P8 and from P11 to P4, see Figure 21-13.

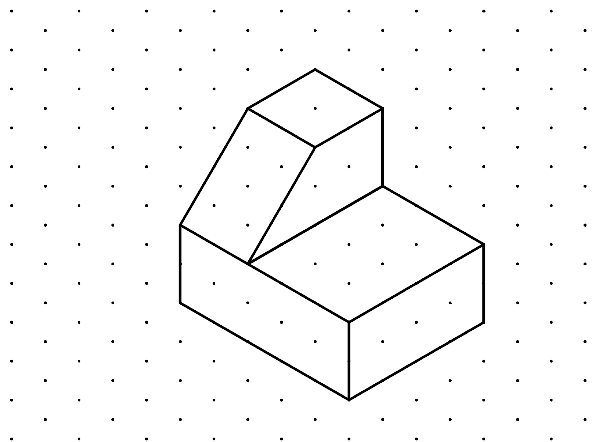


Figure 21-13 Isometric drawing with the tapered face

DRAWING ISOMETRIC CIRCLES

Isometric circles are drawn by using the **ELLIPSE** command and then selecting the **Isocircle** option. Before entering the radius or diameter of the isometric circle, you must make sure that you are in the required isoplane. For example, if you want to draw a circle in the right isoplane, you must toggle through the isoplanes until the required isoplane (right isoplane)

is displayed. You can also set the required isoplane current before entering the **ELLIPSE** command. The crosshairs and the shape of the isometric circle will automatically change as you toggle through different isoplanes. As you enter the radius or diameter of the circle, AutoCAD draws the isometric circle in the selected plane, see Figure 21-14.

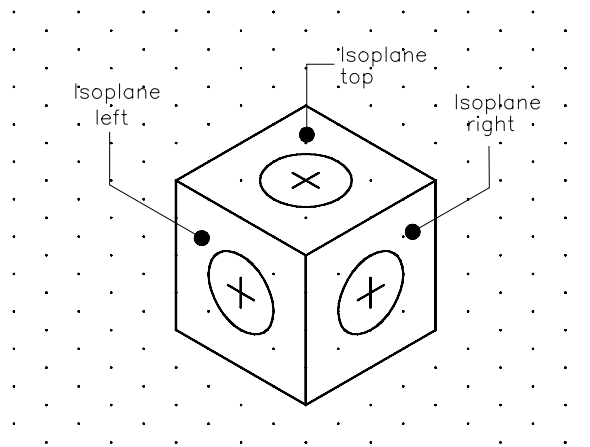


Figure 21-14 Drawing isometric circles

The prompt sequence to draw an isometric circle is:

Command: **ELLIPSE**
 Specify axis endpoint of ellipse or [Arc/Center/Isocircle]: **I**
 Specify center of isocircle: *Select a point.*
 Specify radius of isocircle or [Diameter]: *Enter circle radius.*



Note

*You must have the isometric snap on for the **ELLIPSE** command to display the **Isocircle** option with the **ELLIPSE** command. If the isometric snap is not on, you cannot draw an isometric circle.*

Creating Fillets in the Isometric Drawings

To create fillets in isometric drawings, you need to first create an isometric circle and then trim the unwanted portion of the isometric circle. Remember that there is no method to directly create an isometric fillet.

DIMENSIONING ISOMETRIC OBJECTS

Isometric dimensioning involves two steps: (1) dimensioning the drawing using the standard dimensioning commands; (2) editing the dimensions to change them to oblique dimensions.

The following example illustrates the process involved in dimensioning an isometric drawing.

Example 2*Mechanical*

In this example, you will dimension the isometric drawing created in Example 1.

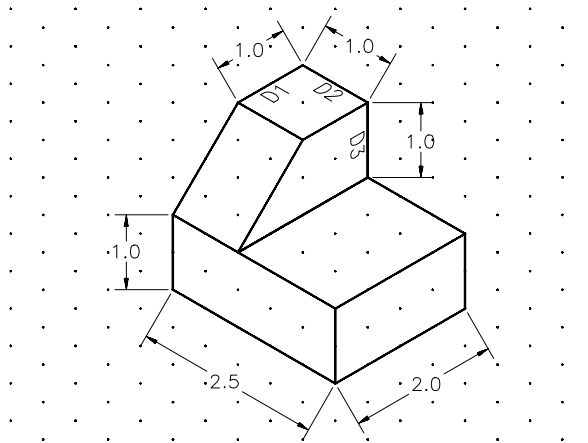


Figure 21-15 Dimensioning an isometric drawing, before obliquing

1. Dimension the drawing of Example 1 as shown in Figure 21-15. You can use the aligned or linear dimensions to dimension the drawing. Remember that when you select the points, you must use the Intersection or Endpoint object snap to snap the endpoints of the object you are dimensioning. AutoCAD automatically leaves a gap between the object line and the extension line as specified by the **DIMGAP** variable.
2. The next step is to edit the dimensions. First, enter the **DIM** command, and then enter **OBLIQUE** at the **Dim:** prompt or use the **Oblique** option of the **DIMEDIT** command. After selecting the dimension you want to edit, you are prompted to enter the obliquing angle. The obliquing angle is determined by the angle the extension line of the isometric dimension makes with the positive X axis.

Command: **DIM**

Dim: **OBLIQUE**

Select object: *Select the dimension (D1).*

Select object: *Press ENTER.*

Enter obliquing angle (Press ENTER for none): **30**

For example, the extension line of the dimension labeled D1 makes a 150-degree angle with the positive X axis [Figure 21-16(a)]; therefore, the oblique angle is 150-degree. Similarly, the extension lines of the dimension labeled D2 make a 30-degrees angle with the positive X axis [Figure 21-16(b)]; therefore, the oblique angle is 30-degree. After you edit all dimensions, the drawing should appear as shown in Figure 21-17.

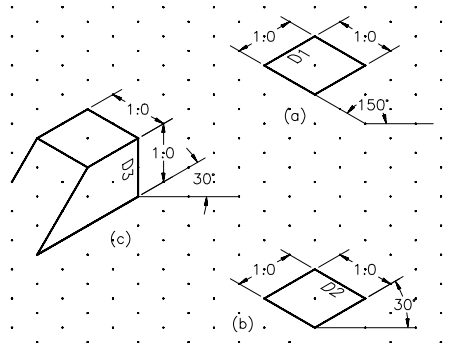


Figure 21-16 Determining the oblique angle

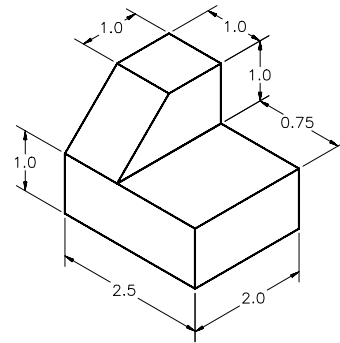


Figure 21-17 Object with isometric dimensions

ISOMETRIC TEXT

You cannot use regular text when placing text in an isometric drawing because the text in an isometric drawing is obliqued at positive or negative 30-degree. Therefore, you must create two text styles with oblique angles of 30-degree and negative 30-degree. You can use the **-STYLE** command or the **Text Style** dialog box to create a new text style as described here. (For more details, refer to “Creating Text Styles” in Chapter 7.)

Command: **-STYLE**

Enter name of text style or [?] <Standard>: **ISOTEXT1**

Specify full font name or font filename (TTF or SHX) <txt>: **ROMANS**

Specify height of text <0.0000>: **0.075**

Specify width factor <1.0000>: *Press ENTER.*

Specify obliquing angle <0>: **30**

Display text backwards? [Yes/No] <N>: **N**

Display text upside-down? [Yes/No] <N>: **N**

Vertical? <N> **N**

Similarly, you can create another text style, **ISOTEXT2**, with a negative 30-degree oblique angle. When you place the text in an isometric drawing, you must also specify the rotation angle for the text. The text style you use and the text rotation angle depend on the placement of the text in the isometric drawing, as shown in Figure 21-18.

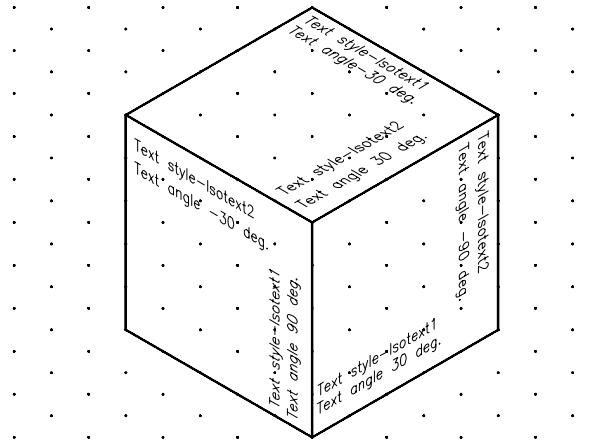


Figure 21-18 Text style and rotation angle for isometric text

Self-Evaluation Test

Answer the following questions, and then compare your answers with the correct answers given at the end of this chapter.

1. The word isometric means “_____” because the three angles between the three principal axes of an isometric drawing are each _____ degrees.
2. The ratio of isometric length to actual length in an isometric drawing is approximately _____.
3. The angle between the right isometric horizontal axis and the X axis is _____ degrees.
4. Isometric drawings have three principal planes: isoplane right, isoplane top, and _____.
5. What key combination or function key can you use to toggle among isoplane right, isoplane left, and isoplane top? _____.

6. You can only use the aligned dimension option to dimension an isometric drawing. (T/F)
7. Must the isometric snap be on to display the **Isocircle** option with the **ELLIPSE** command? (Y/N)
8. Do you need to specify the rotation angle when placing text in an isometric drawing? (Y/N). If yes, what are the possible angles? _____.
9. The lines that are not parallel to the isometric axes are called _____.
10. You should avoid showing any hidden lines in isometric drawings. (T/F)

Review Questions

Answer the following questions.

1. Isometric drawings are generally used to help in _____ the shape of an object.
2. An isometric view is obtained by rotating the object _____ degree around the imaginary vertical axis, and then tilting the object forward through a _____ angle.
3. If you project the points and the edges onto the frontal plane, the projected length of the edges will be approximately _____ percent shorter than the actual length of the edges.
4. When should hidden lines be shown in an isometric drawing?
5. Isometric drawings have three axes: right horizontal axis, vertical axis, and _____.
6. The angles do not appear true in isometric drawings. (T/F)
7. What are the lines called that are parallel to the isometric axis? _____.
8. What commands can you use to set the isometric grid and snap? _____.
9. Isometric grid lines are displayed at _____ degrees to the horizontal axis.
10. It is possible to set the aspect ratio for the isometric grid. (T/F)
11. You can also set the isometric grid and snap by using the **Drafting Settings** dialog box, which can be invoked by entering _____ at the Command prompt.
12. Isometric circles are drawn by using the **ELLIPSE** command and then selecting the _____ option.

13. Can you draw an isometric circle without turning the isometric snap on? (Yes/No)
14. Only aligned dimensions can be edited to change them to oblique dimensions. (T/F)
15. To place the text in an isometric drawing, you must create two text styles with oblique angles of _____ degrees and negative _____ degrees.

Exercises

Exercises 1 through 6

General

Draw the following isometric drawings (Figures 21-19 through 21-24). The dimensions can be determined by counting the number of grid lines. The distance between the isometric grid lines is assumed to be 0.5 units. Dimension the odd-numbered drawings.

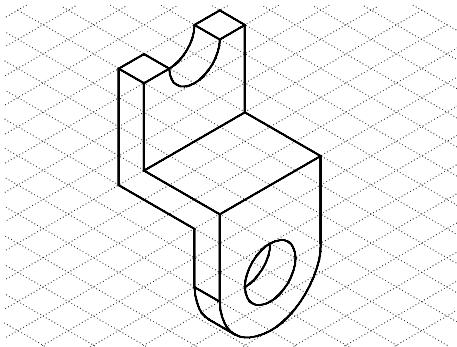


Figure 21-19 Drawing for Exercise 1

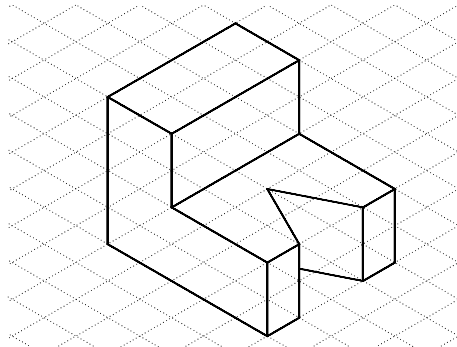


Figure 21-20 Drawing for Exercise 2

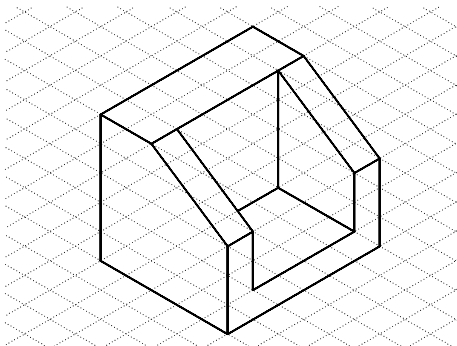


Figure 21-21 Drawing for Exercise 3

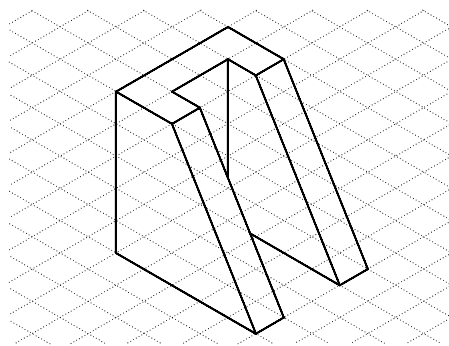


Figure 21-22 Drawing for Exercise 4

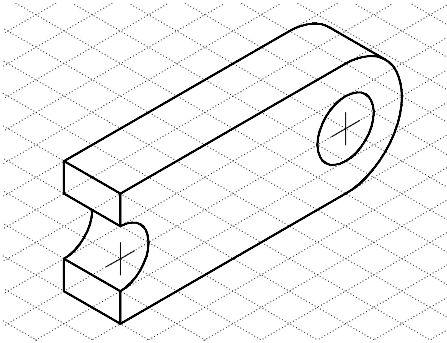


Figure 21-23 Drawing for Exercise 5

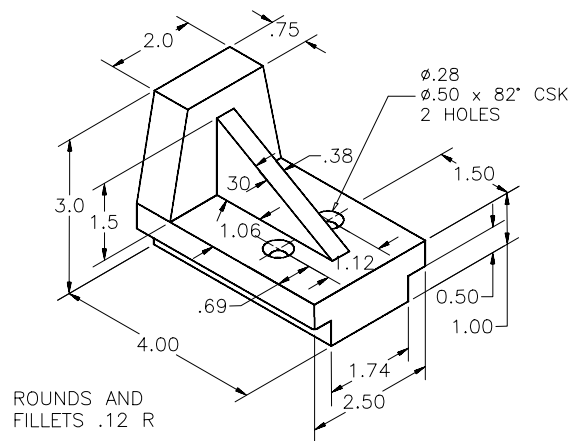


Figure 21-24 Drawing for Exercise 6

Answers to Self-Evaluation Test

1 - equal measure, 120, **2** - 9/11, **3** - 30, **4** - isoplane left, **5** - CTRL+E, or F5, **6** - F, **7** - Yes, **8** - Yes, 30-degree, -30-degree, 90-degree, etc., **9** - nonisometric lines, **10** - T