Normal surfaces are either horizontal or vertical in space. (Parallel to or perpendicular to the Solid Edge reference planes).

Inclined surfaces have a single slant in space. These surfaces are very common in construction (roofs) and on machine parts.

Oblique surfaces have a double slant in space. They are referred to as compound-angle surfaces. (See next chapter).
**Inclined Surfaces in Space**

An inclined surfaces appears as an slanting edge-of-surface in one view and as a foreshortened surface in the other two views. Notice that the “T” shaped surface on the object is perpendicular to the front reference plane and is at an angle to the top reference plane.

Because the T-shaped surface is at an angler to the top reference plane, it’s projection to the top view creates an image shorter than the actual extent of the surface (foreshortened view).

The same is true for the projection to the right reference plane. The resulting view shows a surface shorter than it’s actual extent.

Notice that the shape of the surface is the same in the top and side views.

**Inclined surface theory**

An inclined surface appearing as an inclined line in the front view will appear as a foreshortened surface in the top view and as a foreshortened surface in the side view.

The surface will have the same general shape in each of the views.
An inclined surface appearing as an inclined edge-of-surface in the top view will appear as a foreshortened surface in the front view and as a foreshortened surface in the side view.

The surface will always have the same number of corners and edges.

An inclined surface appearing as an inclined edge-of-surface in the side view will appear as a foreshortened surface in the front view and as a foreshortened surface in the top view.

The surface will always have the same parallel and non-parallel edges in each of the views.

The inclined surface chart is shown below. Read across. This is the complete set of rules for inclined surfaces. Knowing this is true helps to visualize inclined surfaces on drawings.

### Modeling Inclined Surfaces

Specifying Inclined Surfaces
Inclined surfaces may be dimensioned in one of two ways:
- Angle of inclined edge.
- Offset dimensions for inclined edge.

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Inclined Surfaces - Angle Specified

Create a protrusion

- Draw the sketch
- Dimension to shape

Use angular dimension from the pop-down menu

Finish the sketch.

Inclined surface - offset dimension specified

- Draw the outline.
- Use the distance between dimension option.
- Finish the shape.

Tutorial - Inclined Surfaces 1
A drawing of the part is shown below. Note: Front, Top and Left side views are used.
A Left sketch plane is needed to sketch the left side view.

__ Start a new (English) part.
__ Click the + next to Origin
__ Right click each reference plane and turn on the visibility for each reference plane.
__ Check the view orientation using Free Orbit. Front-Right-Top is the usual starting view.

__ Using Free Orbit, roll the planes so the Front-Top-Left orientation is shown.
Start a sketch on the Left Plane

Draw the 1.500 and 2.750 lines. Start at the Origin point.

Draw the 45 degree and 75 degree lines any length as shown.

Draw a temporary vertical line 2.00 inches over as shown.

Use Modify ... Trim to trim the 45 degree line as shown.
Delete the temporary vertical line.
_ Draw the 30 degree line any length as shown.

_ **Trim** the lines to create the finished sketch.

_ **Save** your drawing.

_ **Extrude** the sketch 5.00 inches.

_ **Save** the part.
Start a sketch on the Front plane.

Use Project Geometry to place lines from the part onto the sketch.

Draw the 45 degree triangle and Extrude - remove material.

Start another sketch on the front plane. Project the top and left part edges to the sketch.

Draw a 30 degree line any length. Trim the lines to form a 30 degree triangle.

Extrude - remove material to create the surface.

Save the finished part. (Set Block)
Make a drawing. Place Dimensions. Save and Print.
Inclined Surfaces

Tutorial - Inclined Surfaces 2
Some part features must be modeled using an inclined reference plane.

In the example the base was modeled first then the inclined protrusion was added. Choosing the start point for the base in relation to the reference planes is very important when beginning a new construction. The upper corner of the base was the critical location. The base was drawn in the 3rd quadrant.

Start a new Part. Dimensions for this layout are METRIC.

Turn ON visibility for Reference Planes.

Start Sketch on Front Plane

% Turn ON visibility for Reference Planes.

% Start Sketch on Front Plane
Start the sketch at the Origin point

Sketch the base outline as shown.

Extrude the base 100mm

SAVE the part ANGLE BASE.

Create a work plane through the edge as shown. Follow steps to create the work plane.

Angle was measured from the vertical face.
Start a sketch on the work plane.

Draw the outline as shown.
(See drawing on previous page for dimensions)

Extrude the sketch to the top surface of the base.
Create the Counterbored Hole

- Use the Hole option.
- Concentric.
- Set the values as shown.
- Save the part.
A detail drawing is used to produce a part. It must have all the information needed to build the part.

- Views - to define and clarify the shape.
- Dimensions - to specify size and accuracy.
- Shop manufacturing notes.
- Materials, etc.

### Dimension Accuracy

All dimensions except for a few special forms have a required accuracy. No dimension can be perfect so an allowable error must be shown.

Some dimensions must be more accurate than others. One method of specifying the accuracy is by the number of decimal places shown in the dimension. .X, .XX and .XXX all have a different accuracy requirement. This is shown in the Tolerance Block. Two decimal places (+/- .03in) is common for most dimensions. (.06 inches is about the thickness of a dime).

#### Tolerances

**English**

- .X = +/- 0.10 in
- .XX = +/- 0.030 in
- .XXX = +/- 0.010 in

**Metric**

- M = +/- 0.8mm
- 0.M = +/- 0.3 mm

**Angles**

- +/- ½ degree

_A Tolerance Block is shown in the title block for Detail drawings._
Angle Base Drawing

Create the regular views.
(B-size metric drawing)

Click the Auxiliary View icon.

Click the front view and click the 60 degree line to set the direction.

Place the auxiliary view.

Dimension as shown.

Dimensions must be placed where the shape shows best.
Problem 1.
A. Model the part.  B. Create a drawing. Front, top, right and isometric views.
C. Animate Front-top-front-right-front.

Height of groove

Distance from bottom of part to bottom of groove.

Problem 2.
A. Model the part.  B. Create a drawing. Front, top, right and isometric views.
C. Animate Front-top-front-right-front-isometric-front.

45° ANGLE
BOTH SIDES

60° ANGLE
Problem A.
Front and right views are shown. Model the part. Make a drawing, dimension the views.

Problem B.
Front and left views are shown. Model the part. Make a drawing, place dimensions. (Do not dimension to hidden lines).

Surface "Z" is an inclined surface.