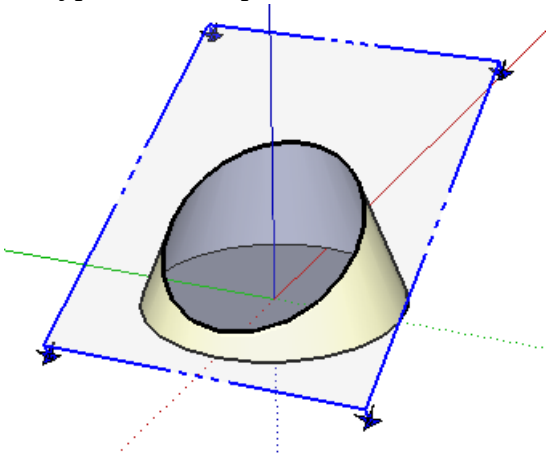
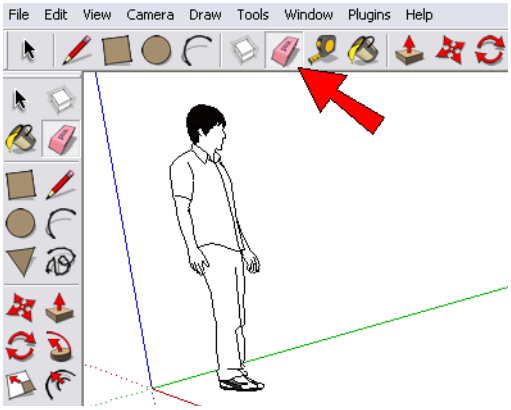
Conic Sections in Google SketchUp

In this project, we'll start with a basic 3D shape: a cone. From that one object, you can use section planes to create four different curves: a circle, ellipse, hyperbola, and parabola.



Step 1: Create the Cone

1. Open Google SketchUp. If your file contains a person standing on the ground near the origin, click the **Eraser** tool and erase him.

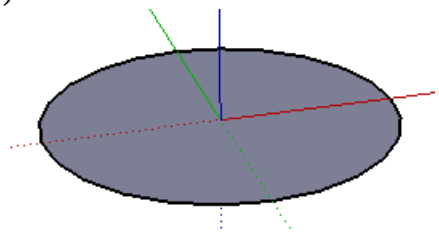


2. We need to see the axes for this project (the red, green, and blue lines), so if yours aren't displayed, choose **View / Axes** from the main menu.

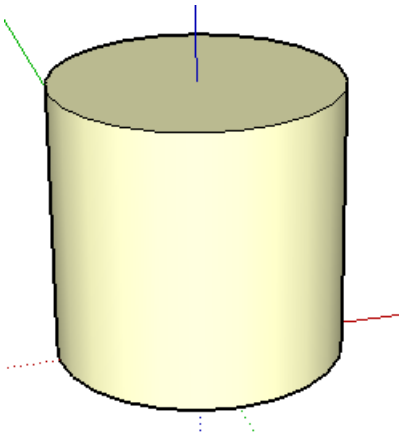
3. Many of the tools for this project aren't available in the default toolbar that runs across the top of the SketchUp window. For the more complete toolbar (which includes most, but not all SketchUp tools), choose **View / Toolbars / Large Tool Set** (PC) or **Views / Tool Palettes / Large Tool Set** (Mac).

4. A cone is derived from a cylinder, which is derived from a circle. So click the **Circle** tool.

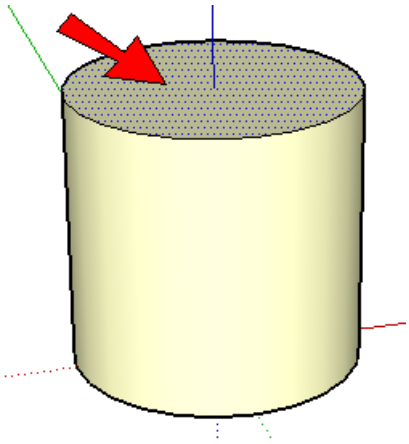
5. Place the center of the circle at the origin (where the three axes meet), and create a circle of any size sitting on the ground (the red-green plane).



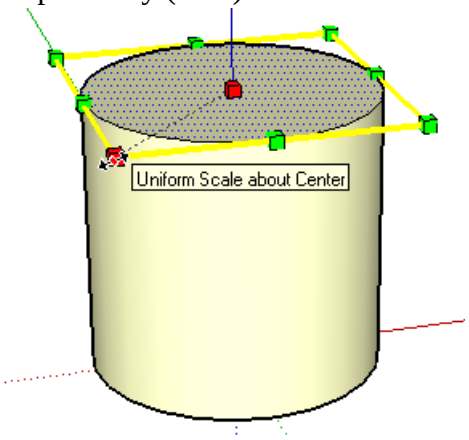
6. To make the cylinder, activate the **Push/Pull** tool. Then click the circle (the face, not an edge), move the mouse up, and click again when the cylinder has the height you want.



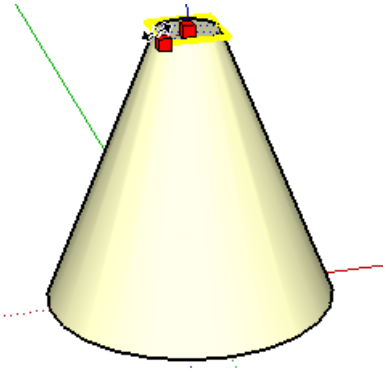
7. Now we can change the cylinder into a cone, by shrinking the top face. First, activate the **Select** tool, then click the top face of the cylinder to select it.



8. With the top face still selected, activate the **Scale** tool. A set of green boxes, called “drag handles,” appears around the face. To shrink this face about its center, place the cursor on one of the corner handles (don’t click yet), and press and hold the Ctrl key (PC) or Option key (Mac).

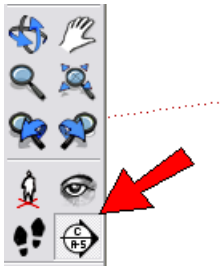


9. Click and drag this handle to shrink the face. Don’t move your cursor too far, or you’ll turn the face inside out!

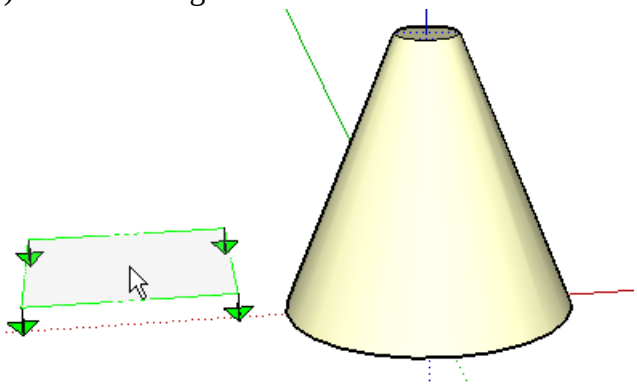


Step 2: Circle and Ellipse

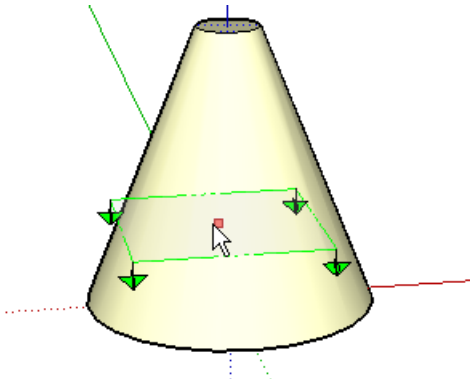
1. We’ll now slice through the cone. Activate the **Section Plane** tool.



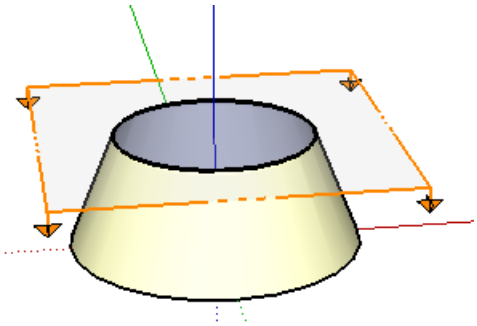
2. Keep the cursor in blank space, so that the section plane preview (which is green with four downward-pointing arrows) is flat on the ground.



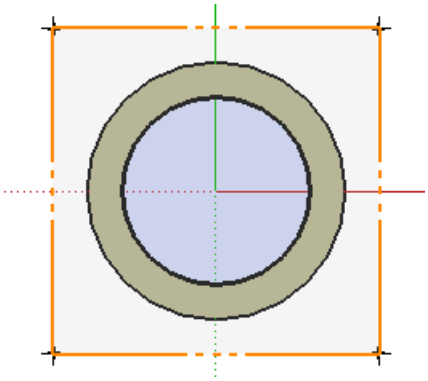
3. Press and hold the Shift key, which keeps the section plane flat. Then move your cursor somewhere on the cone.



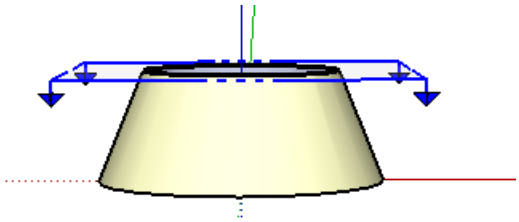
4. With Shift still pressed, click to create the section. Now the top part of the cone is sliced off, and you can see inside.



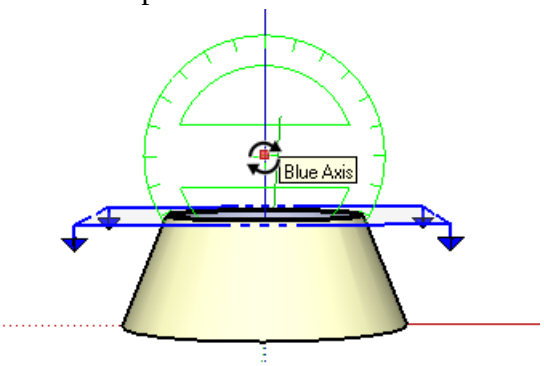
5. Orbit so that you are looking straight down into the cone. Where the cone meets the section plane you should see a circle (pretty obvious, right?).



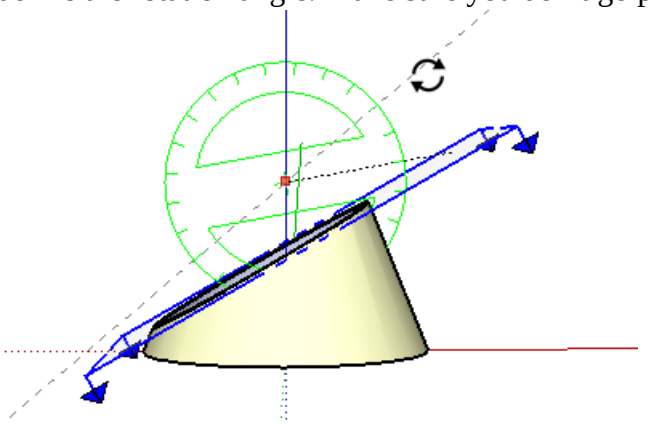
6. To change the circle into an ellipse, the section plane needs to be tilted. First do two things: activate **Select** and click the section plane (it should turn blue when selected), and orbit so that you're facing the side of the cone, looking straight along the green axis. The red axis should go off to the right and left.



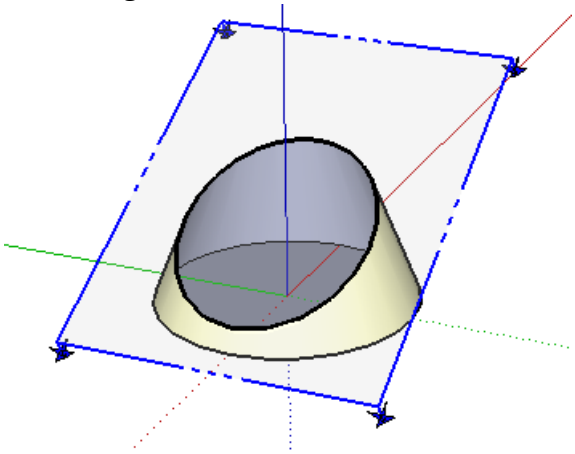
7. Activate **Rotate**. The protractor appears, and should be green. (If it's not green, move your cursor up a little until the protractor turns green, then press and hold the Shift key to keep it green.) Click to place the protractor on the blue axis, just above the section plane. This point defines the center of rotation.



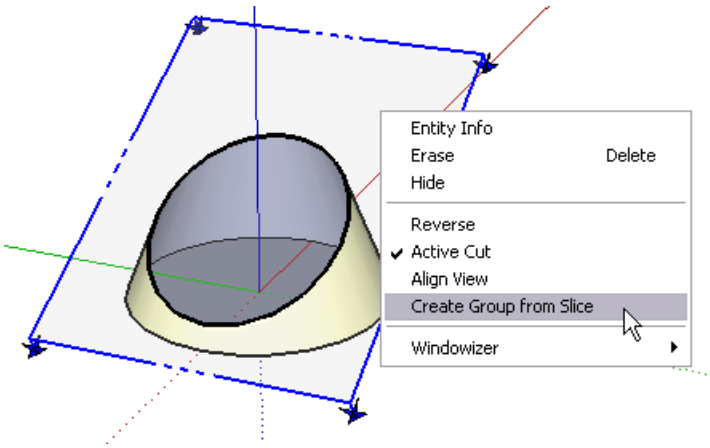
8. Then click two points that define the rotation angle. Make sure you don't go past the bottom of the cone.



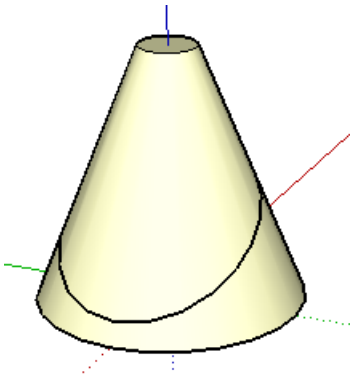
Your model should now look something like this. The curve within this section plane is an ellipse.



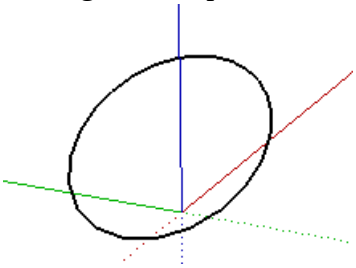
9. To save this ellipse, right-click anywhere on the section plane (not within the cone itself), and choose **Create Group from Slice**.



10. The section plane is no longer needed, so click the **Eraser** and erase the section plane (click on one of its edges, not in the middle). Now you have the cone and the curve.

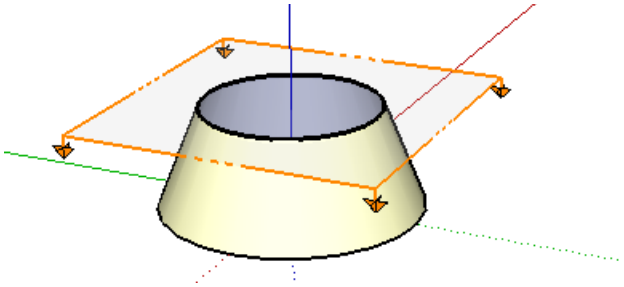


11. Erase the cone, which you can do by clicking on its top and bottom edges. Now just the ellipse is left.

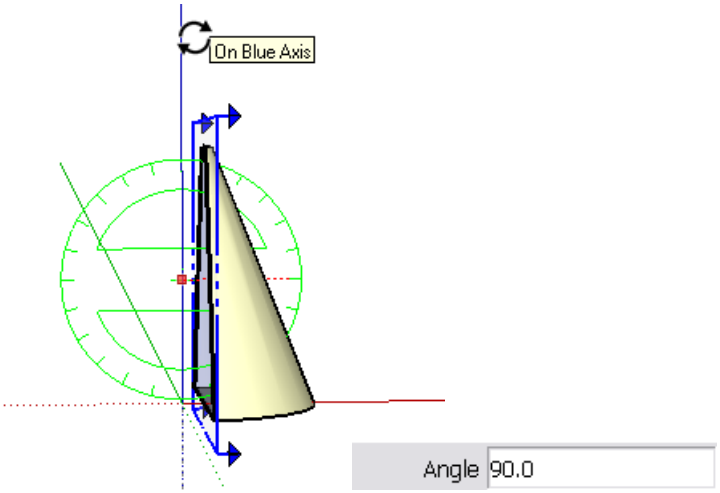


Step 3: Hyperbola

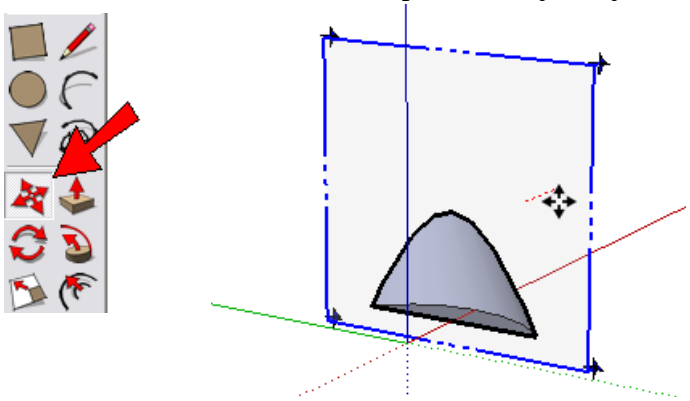
1. Start a new file, and create a new cone. Place a section plane inside the cone, like you did before.



2. Select the section plane, activate **Rotate**, and this time make the section plane vertical. This means the rotation angle should be 90 degrees, which you can check in the **Angle** field.



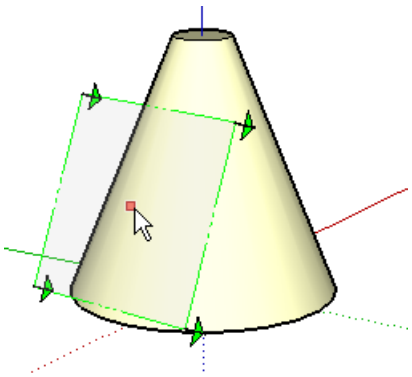
3. This creates one hyperbola, but you can move the section plane back and forth within the cone, to get differently hyperbolas. To do this, make sure the section plane is still selected, and activate **Move**. Click the section plane and move your cursor back and forth - the plane always stays oriented the same way.



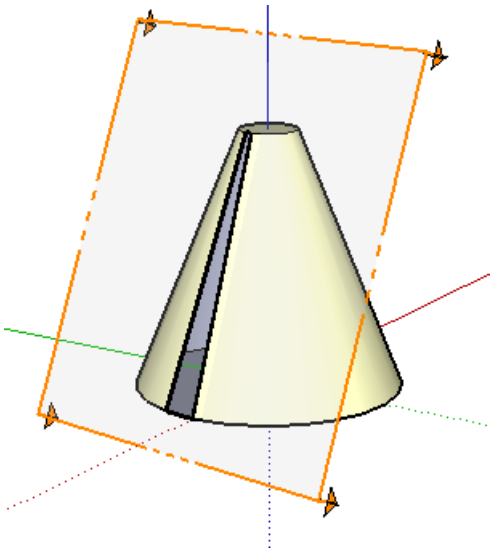
Step 4: Parabola

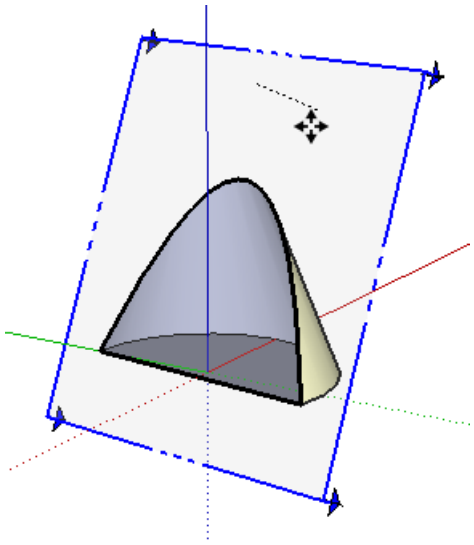
A parabola is created when you slice through a cone in a direction *parallel to the slope of the cone*. So we need to section this cone a different way.

1. Once again, start a new file and create a new cone. Activate **Section Plane**, but this time don't press the Shift key to keep it flat. Instead, move your cursor around the cone; the section plane aligns to whatever face the cursor is on.



2. Click any face to section it. Then select the section plane and use the **Move** tool to push the plane farther into the cone.





3. Use the **Create Group from Slice** option, then erase both the section plane and cone. Here's your parabola, plus a horizontal line at the bottom: