

# Paraboloid Mirror Design Using Scilab

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## Abstract

Paraboloids are useful in solar heating, antennae and ultrasound applications. This article discusses design of a paraboloid for convenient fabrication. Scilab helps this design to achieve better accuracy.

## 1 Introduction

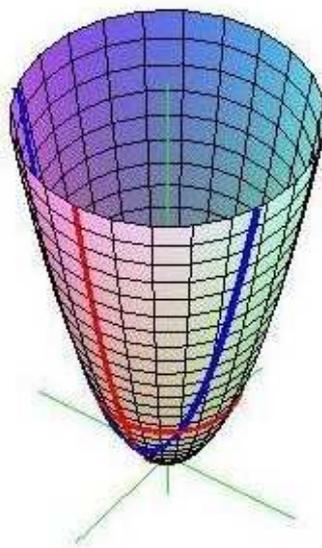


Figure 1: Paraboloid segments & sectors

Parabolic mirrors are useful in solar heating, antennae and ultrasonic applications. Fabrication of such mirrors will be easy if the paraboloid is

decomposed in many sectors and segments. Using plain thin sheets, it is possible to fabricate such a paraboloid. Mathematics helps us to calculate dimensions of the components. Use of Scilab makes these calculations easier. If the user chooses parameters appropriately, the Scilab script instantaneously calculates these dimensions and plots a drawing. The Scilab script considers following parameters:

1. **Sectors:** If we consider the paraboloid as a flower, sector is like the petal of the flower. *More are the sectors, better is paraboloid shape.* However, as the sectors are larger in number, they become lesser in width and assembly of these sectors becomes tedious. Choosing sectors within the range 12 to 36 may be a good engineering compromise.
2. **Focal length:** Consider the paraboloid directly facing the sun. Sun rays, after reflecting from the bright paraboloid surface, will converge to a single point. This point is called the focus of the paraboloid. Distance of this point from the lower-most point of the paraboloid (called as vertex) is known as the *Focal Length*.
3. **Height:** The upper rim of the paraboloid is called as the aperture. Distance between the vertex and the upper rim is the *height* of the paraboloid. For solar cookers, the height and the focal length is normally the same.
4. **Segments:** Consider the paraboloid is made up of many small cylinder-like structures of reducing diameters from top to bottom. Each such cylinder-like structure is termed as the segment of the paraboloid. The figure 1 shows circular-segments of a paraboloid mirror.

**Please Note:** Fabrication of the paraboloid is easier if we go sector-wise instead of segment-wise. However, to calculate precise dimensions, Scilab needs many such segments. Finally the fabricator will use the sector-wise approach.

## 2 About Scilab

Scilab is a free and open source alternative to Matlab. You can download it from [scilab.org](http://scilab.org). Scilab-5.4.1 is the current version. You can run the script `parabola.sce` using this software. You may also download another fork of original “Scilab” at <http://www.scicoslab.org>.

### 3 Using the paraboloid script

You must have downloaded the Scilab script **parabola.sce** from the site <http://www.scilab.babavakyam.com>. To run the script follow the steps given below.

1. Start the Scilab software, you see a command terminal.
2. Start the “scinotes” editor by clicking the icon or typing the command “scinotes”.
3. Open the script “parabola1.sce” in “scinotes”.
4. Press the menu button *Execute-¿ file with no echo....* **ctrl+sh+E**.
5. Fill the values in the box that appears on the screen. Replace default values.

$$\textit{Sectors} = \textit{number in the range 12 to 40.} \quad (1)$$

$$\textit{focal length} = \textit{focal length} \quad (2)$$

$$\textit{height} = \textit{distance between vertex and upper rim.} \quad (3)$$

$$\textit{Segments} = \textit{number in the range 6 to 20.} \quad (4)$$

If you keep the default values, you will get dimensions of a paraboloid that is useful for a solar cooker for a family of four.

### 4 Easy fabrication guide

To fabricate the paraboloid, you need the **Petal Diagram**. When you run the **paraboloid.sce** script in Scilab, you see two graphic windows:

#### 4.1 Petal dimensions

Refer figure of the petal 2 on page 4. **Scilab graphic window-1** shows petal dimensions. This drawing is useful for actual fabrication.

1. Carefully observe the drawing. It is one of the petals forming the full concave surface.
2. The petal may look like a triangle, but *it is not a triangle*.
3. The pointed ends together form the vertex of the paraboloid. We call this end as the vertex end. The other end is the base of the petal.

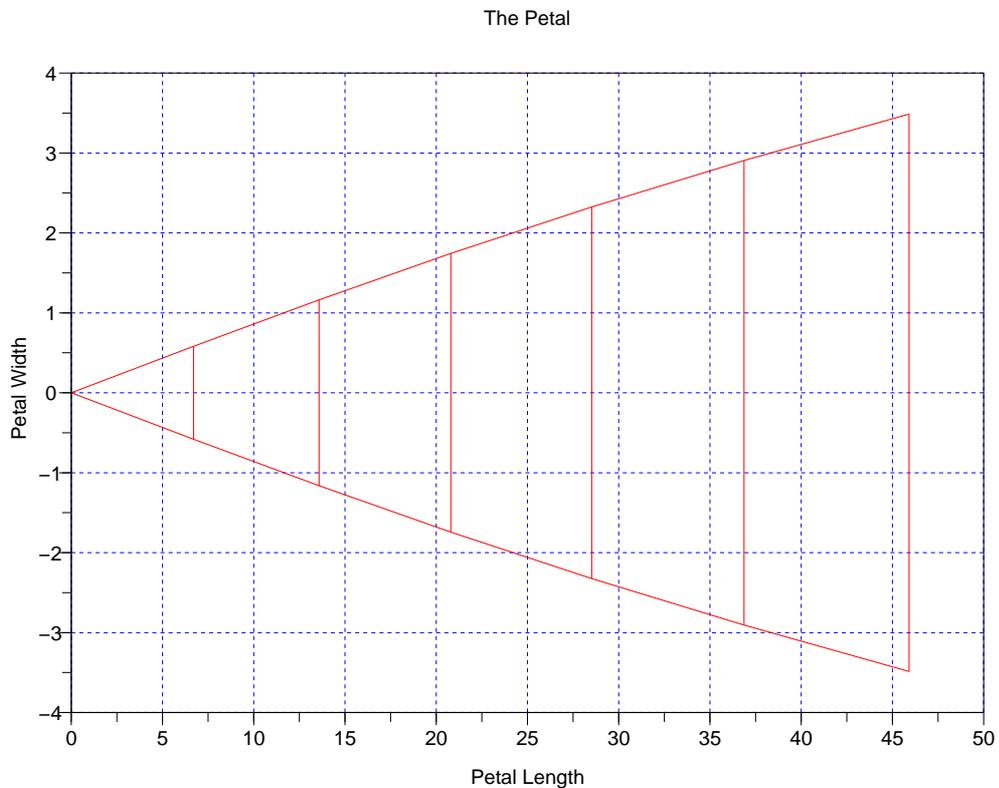


Figure 2: Petal of a paraboloid

4. On x-axis, note the largest x-coordinate. This is the length of the petal.
5. Cut a rectangle from your material, such that its width equals petal-base and length equals the petal length. You will need many such rectangles to form the full surface. Number of such rectangles equals the number of sectors.
6. Observe the red vertical lines on the petal diagram. While cutting the sector from the sheet material, Mark the red lines exactly on the same positions as shown in the diagrams. The length of the red lines also must be the same.
7. Now cut the petal with the red markings on it.
8. Cut all the petals needed in the same way.
9. While joining the petals together, match the corresponding red marks

so that you will see the red circles on the reverse side of the surface. Once you do it, the concave surface is automatically formed. The petal bases will form the upper rim of the paraboloid and the vertex ends will form the vertex of the paraboloid.

10. On the concave surface, stick glossy/ reflecting paper. If you use stainless steel, the surface will be directly useful to reflect sunlight.
11. Your concave mirror is ready.
12. Now mount it on suitable stand so that you can orient it to face the sun.

## 4.2 Mirror-Vertical Section

The figure on page 6 is figure 3 from **Scilab graphic window-2**. It shows vertical cross section of the paraboloid. The figure 3 is vertical section of the paraboloid showing the shape and position of the focal point by red stars.

## Contact Us

If you fabricate the surface using this Scilab script, please let us know about it. About your doubts and questions, please write to us at:  
**[prayogshala@babavakyam.com](mailto:prayogshala@babavakyam.com)**

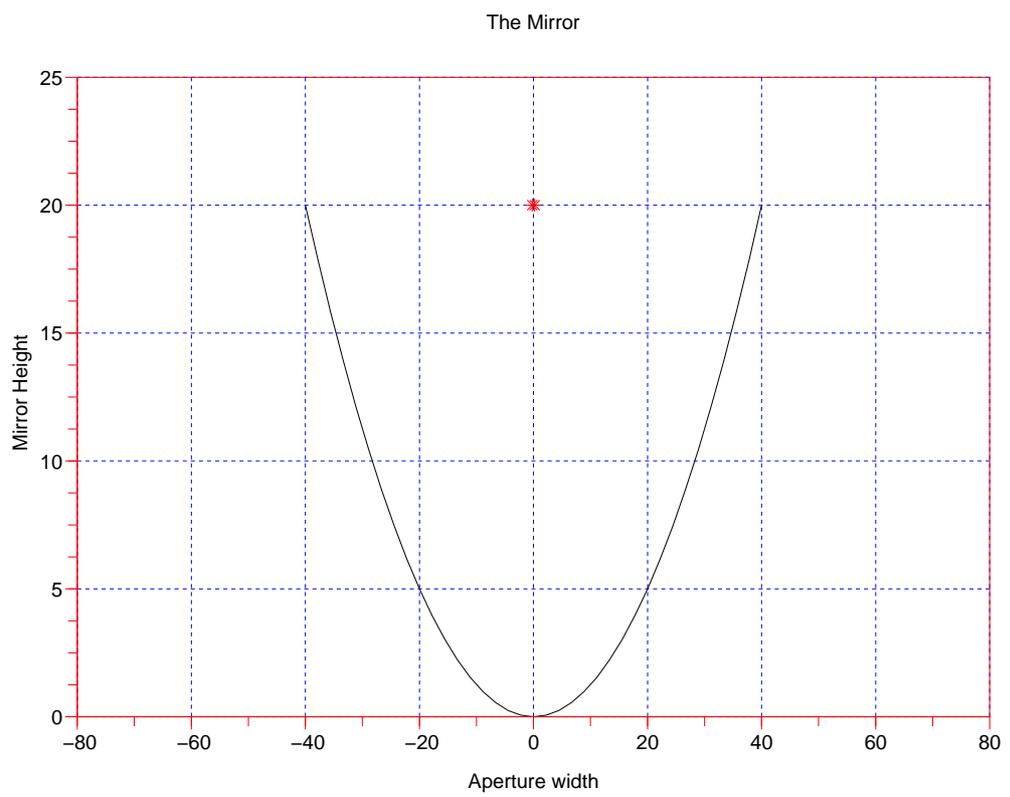


Figure 3: Paraboloid Mirror