The Grinding Process

The first task in the mirror grinding process is to produce the proper curvature for the focal length desired. The depth of the curve at the center of the mirror is called sagitta (*sajitaw*). There is a simple math formula to calculate sagitta,

$$s=r^2/2R$$

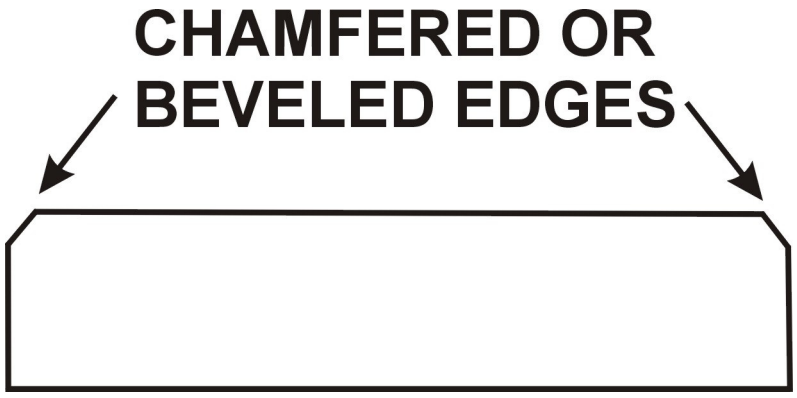
Where **r** is the radius of the mirror, and **R** is the radius of curvature (which is also twice the focal length). For a 6" mirror with a 48" focal length, r= 3" and R=96". Sagitta is then:

$$3^2/2(96) = 9/192=.0469"$$

A neat program is found on the web at:
http://www.atmsite.org/contrib/Prewitt/sagitta/
See also http://www.stellafane.com/atm/atm_select_scope/atm_sag2fl_calc.htm

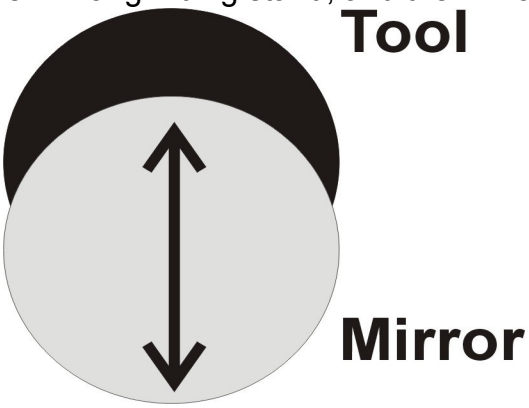
It's possible to purchase mirror blanks that are already pre-curved to a specific focal length, but for smaller mirrors it is not that much extra work for mirrors that are in the f/5 and up range.

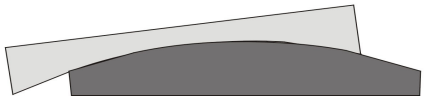
Chamfering
Sharp edges on a mirror or tool will have a tendency to chip during the grinding process. If this happens the edge looks ragged, but more importantly the glass chips could create scratches in the fine grinding and polishing stages. One way to minimize this is to bevel off the edges of the mirror blank and tool. Techniques for doing this will be discussed before grinding starts.



Grinding techniques

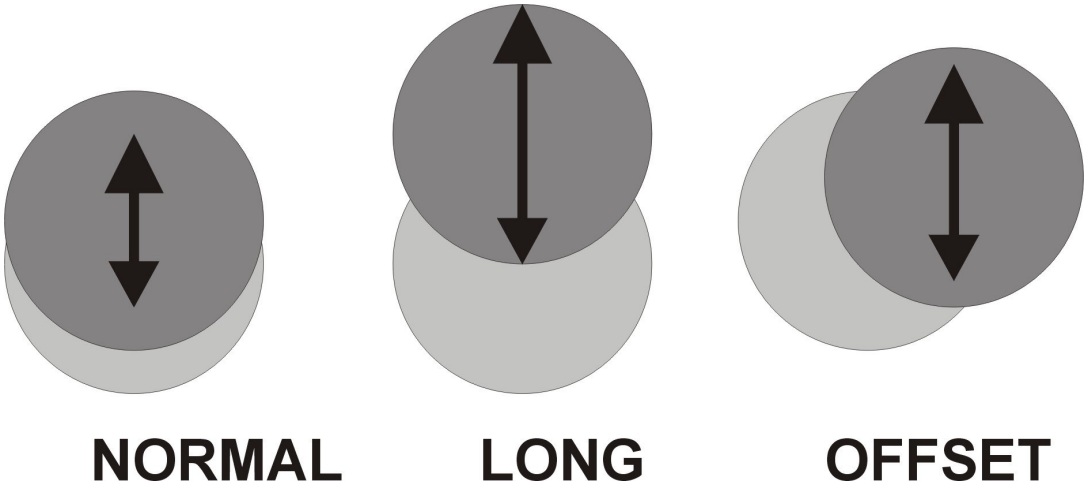
Although there are many ways to grind and polish a mirror we are going to use the traditional method of “mirror on top”. This means that the tool will be fixed on the mirror grinding stand, and the mirror will be manipulated by hand on top of the tool. The tool is mounted rigidly on the grinding stand. A thin layer of water and a small amount of “grit” is applied to the tool. The mirror blank is moved back and forth over the tool center over center.





As the mirror overhangs the tool, the weight of the mirror exerts more pressure on the edge of the tool and the center of the mirror. The tool tends to become convex, and the mirror concave.

The normal grinding process calls for the mirror maker to walk around the grinding stand, sliding the mirror back and forth over the tool, while rotating the mirror. This sounds complicated, but it’s not. A normal stoke is back and forth, center over center so that about 1/3 of the mirror overhangs the tool at the end of the stroke. For a 6” mirror this amounts to a 2” overhang.
Hogging out is a term used to describe a significant removal of glass. Hogging out requires a coarse grit and a longer stroke. Half the mirror will overhang the tool. For a 6” mirror this amounts to 3”. It is also possible to **offset** the stroke so that the mirror is not passing center over center.



Abrasive Grits

The abrasives used for mirror grinding are usually Silicon Carbide(SiC) also known as Carborundum for rough grinding and Aluminum Oxide (AlO) sometimes known as Alumdum for fine grinding. Grits are graded according to a grit number or grit size in microns.

#	Average size (microns)	Purpose
80	165	Hogging
120	102	Rough Grinding
220	63	Rough Grinding
320	32	Fine Grinding
400	22	Fine Grinding
600	15	Fine Grinding
1200	5	Fine Grinding

If a very deep curve is to be generated #60 grit is a possible starting point. There is a wide range of grinding styles so It is difficult to predict exactly how long it will take reach the desired curvature. Starting with a flat surface a normal stroke and #80 grit it took about three hours of actual grinding to get to a 42" focal length 4-1/4" mirror. #120, #220, and #320 grit reduces the focal length very close to the required 34" for an f/8.

During the rough stages of grinding the process starts out very noisy. After a short time the grit breaks down and noise is reduced. More grit and water is needed. Less grit is generally better than more grit. The grit should not be allowed to dry out. It will not take long to get the feel of grit and water amounts.

The fine grinding smoothes the surface preparing it for polishing and does not radically change the focal length. Visual inspection basically determines the time consumed at each stage of fine grinding. Focal length can be manipulated slightly if you are a stickler for a precise focal length. Grit and water is mixed in a

squeeze bottle to help prevent scratches due to “clumping”. The surfaces are getting very smooth and may begin to stick together.
Some important points:

- Contamination is your enemy
- Each grit must be carefully stored separately to prevent contamination
- Water for each stage should be handled carefully
- Thorough cleaning is required between each stage of grinding
- Make sure your clothing and body are free of contamination
- Finer grits may clump together causing scratching

You cannot just read about grinding. Actual experience is the best teacher.