Grinding Lenses

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1 Introduction

This module 'Grinding Lenses follows the module 'Lenses' or 'Parabolic Mirrors' and can lead to 'Telescopes'. When you completed all these modules you should be able to make your own telescope with the help of the module 'Making your own telescope' and explain how it works. This module, like 'Parabolic Mirrors' is more technical then the previous ones because it focusses more on constructing a lens then on the mathematics behind the workings of a lens.

It is assumed that you know and understand the Pythagorean theorem.

2 Constructing spheres

A sphere is a three-dimensional surface, all points of which are equidistant from a fixed point; the centre. This distance is called the radius r. Using the Pythagorean theorem we can describe the surface of a sphere (in Cartesian coordinates) in a single mathematical formula:

$$x^2 + y^2 + z^2 = r^2 \tag{2.1}$$

Lets see what happens when we cut away a slice of the sphere. We take a sphere with a radius of 5.0 cm and take away a 1.0 cm thick slice. We made the cut at $z = 4.0$ cm.

$$x^2 + y^2 + 4.0^2 = 5.0^2 \;\Rightarrow\; x^2 + y^2 = 3.0^2$$

This equation tells us that the cut made is circular in shape and has a radius of 3.0 cm. Making a plano convex lens is therefore easy, just slice of a piece of a glass sphere. First however we need to obtain a (part of a) glass sphere.

Grinding lenses can be done by rotating a glass pane and 'cutting' away glass from the top with a rotating cylinder which is placed at an angle to the rotating plane. Machining in this fashion will result in a partial sphere. A suitable cylinder to use if you want to try this process for yourself is a hole saw. See figure 2.1 for a possible setup to grind lenses.

It is important to align the axis of rotation in such a way that axis of the hole saw cuts crosses the axis of the rotating pane. Trying this process with glass can be quite dangerous, a safer alternative is Plexiglas (Poly(methyl methacrylate), PMMA). If everything is rotating properly we end up with a nice

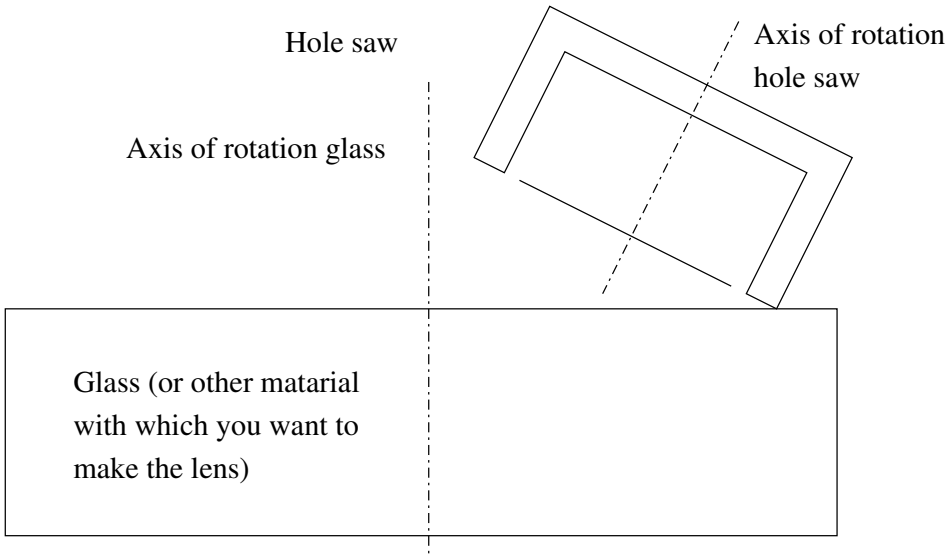

Figure 2.1: A setup to grind lenses.

sphere (without a strange tip at the top). The hole saw however cuts away material quite crude, we therefore do not obtain a nice smooth surface.

After cutting we can sand down the surface to make it smoother. To do this take a piece of tubing with the same diameter as the hole saw and cover the end with sandpaper. Use this 'sander' in the same way as the hole saw. A different method uses grinding paste made from water and fine sand to polish the surface. Multiple polishing steps are needed, each with a finer polishing paste. Scouring cleaning agents can be used as an intermediate coarseness and copper polish as the finest polish. When we are done with polishing we end up with a plano convex lens. The lens makers equation can be used to calculate its strength.