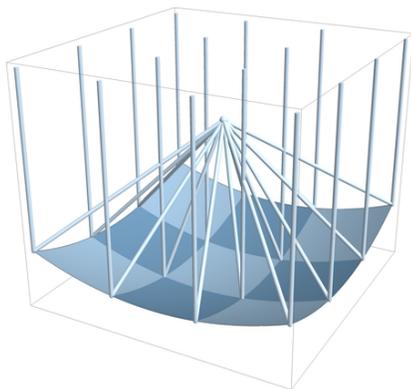


Math 4250 Extra Credit Projects: Quadratic Surfaces.

1. (20 points) (Extra Credit) You proved in the “Understanding Quadratic Surfaces” homework that parallel rays of light striking a perfectly reflective and perfectly shaped paraboloid should converge at a single point^a on the axis of revolution, as shown below left.



Paraboloids of this type are called “parabolic dishes” and are used to concentrate sound waves, radio waves, and light, particularly in solar energy applications, such as the solar furnace shown above right.

Construct or obtain a concave dish which is as close to being an elliptic paraboloid of revolution as you can manage. Line it with something reflective. Rays of sunlight arriving on Earth are almost parallel, your shape is (hopefully!) pretty close to being a true elliptic paraboloid of revolution, and the reflective material is close to being a perfect reflector. All of these things mean that light rays striking your dish may converge to *nearly* the same point on the axis.

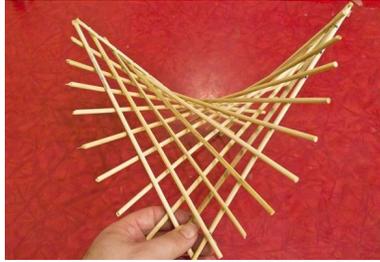
Test how well your construction collects sunlight by pointing the axis of the dish directly at the sun, measuring the temperature at the focus of the paraboloid and comparing this to the air temperature around the dish. If your dish focuses light effectively, the temperature will be higher at the focus. Can you collect enough sunlight to melt a chocolate bar? Boil water? Toast a marshmallow? Submit a written description of your construction process, along with photographs documenting each step of the experiment. Submit at least one photograph showing you with your construction.

Construction notes: It is often possible to obtain old satellite dishes (for example, from the Dish network) very cheaply. Check Craigslist or Facebook marketplace. Other construction options include cardboard, paper, and lining a shallow dish with modeling clay and shaping it with a template. Aluminum foil is a good reflective material.

Important safety notes: This experiment can work well enough to produce a lot of heat. Be very careful (you’re legal adults; please act accordingly). Do NOT make a paraboloid much larger than a pie plate. (Large satellite dishes covered in a good reflective material can be quite dangerous.) Keep your hands and hair well away from the focus of your dish, and wear oven mitts. Measure temperatures with a long thermometer. Do not boil water in a sealed container. Toast marshmallows on a stick.

^aVery reasonably, this point is called the *focus* of the paraboloid.

2. (20 points) (Extra Credit) Construct your own hyperbolic paraboloid using two sets of straight rods, as below:



and in the video posted above this homework. There are many different ways to do this, and you're encouraged to be creative! If you want very detailed instruction on how to do this, they are available from this link to mathcraft.wonderhowto.com.

Submit photographs of you with your construction and a description of your method.