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How to build and operate a solar reflector for small (20.5" long) solar tubes



Caution: make sure you wear [protective goggles](#) such as “shade 5” welding goggles. Infrared light can damage your eyes.



1. Base Assembly

Make a rectangular base from four pieces of wood (two 98.5 cm x 7 cm x 3.5 cm, two 73.5 cm x 7 cm x 3.5 cm), with two supports in the middle.



2. A-frame

Take two pieces of wood (76 cm x 7 cm x 3.5 cm), cut them at the same angle (60 deg) and join them to create an “A” shape. Add a piece of wood (29.5 cm x 7 cm x 3.5 cm) to “cross the A,” making sure that the cross is at least 40 cm above the ground. Repeat for the other side.



Connect the bottoms of the A shapes to the Base Assembly, making sure that the points of the A are in the middle. The mirror frame will be mounted near the top of the A, so that it can rotate with the sun's movement across the sky each day. You will need short cross pieces with a hole in the center to make that attachment. Below we used a short piece of plastic pipe as a spacer to keep the mirror frame from shifting. To make sure the holes were aligned, we used a wooden dowel and then cut it after it had been inserted in both sides.



3. Mirror frame

Take four pieces of wood, make a rectangular frame (two 96 cm x 5 cm x 2 cm, two 72.5 cm x 5 cm x 2 cm).

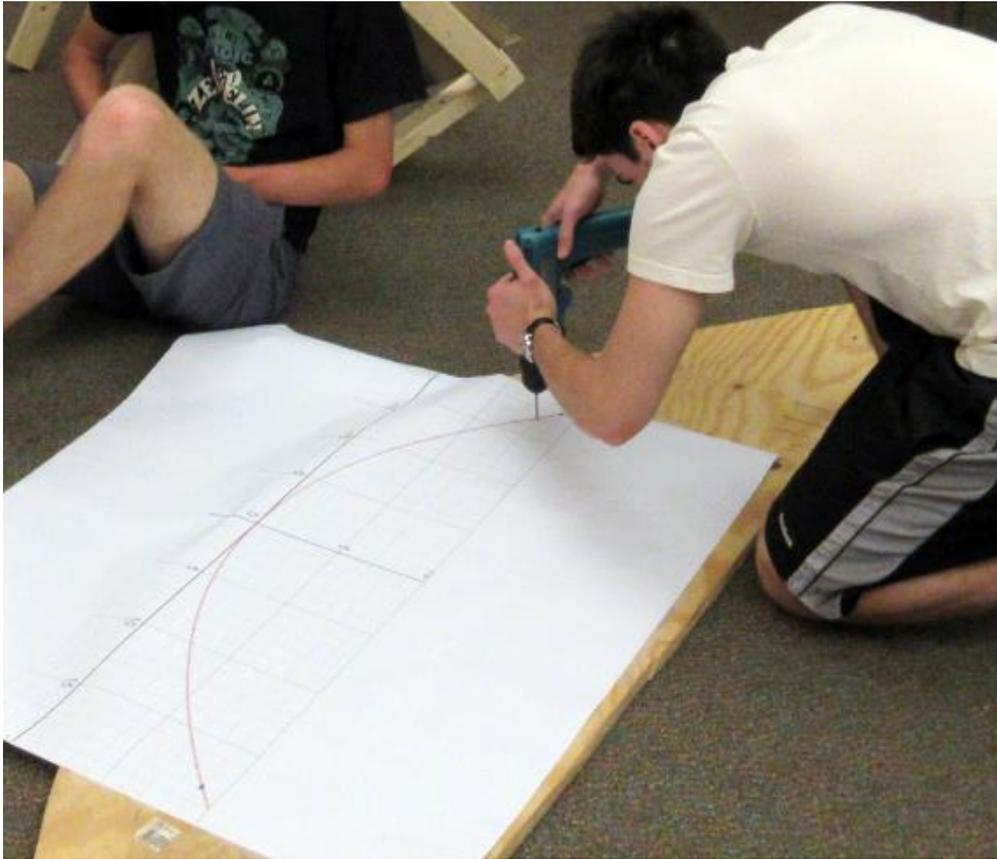
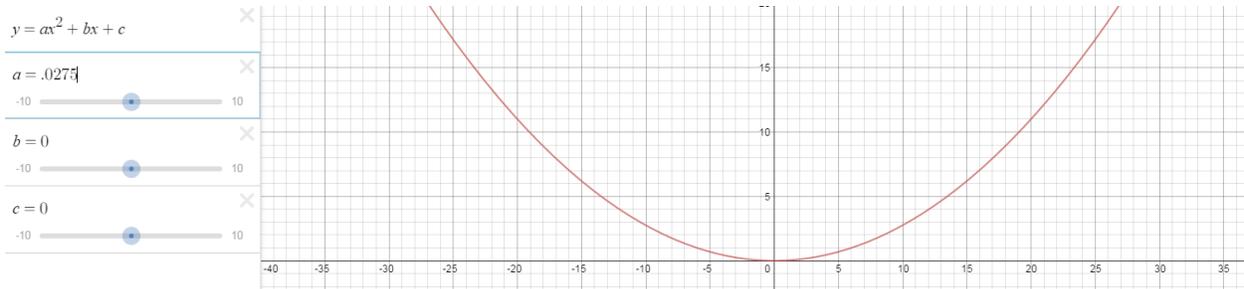
At the center of the 96 cm lengths, cut a hole to allow the frame to rotate when attached to the A shapes. In the photo below there appears to be interior crosspieces, but if you look closely you can see those are actually from the base, below the (black) mirror frame. Make two curved ribs (99.5 cm long) and attach them by setting them inside the frame. See "mirror" below for curve equation and cutting suggestions.



4. Parabolic mirror

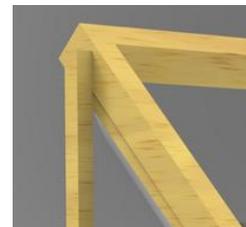
The mirror is an aluminum backing, with a [reflective Mylar foil](#) glued on. The aluminum backing sheet is 27 inches by 4 feet when flat. When curved, the reflector is 36 inches wide and 9 inches

deep. The [parabolic equation](#) below gives $y=ax^2$ where $a = .0275$. Focus = $1/4*a = 9.09$. To create the ribs we simply printed out the curve on paper and used it as a template for cutting the wood by drilling small guide holes every inch or so along the curve, and then cutting with a jig saw.

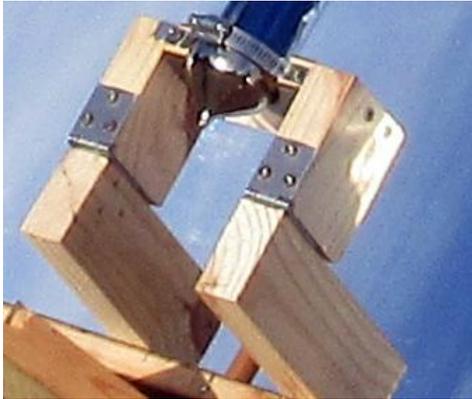


4. Adjustable legs

The legs simply attach at the rear corners and swing out to allow an adjustable angle. Wing nuts are recommended to allow seasonal adjustments.



6. Solar Vacuum Tube attachment



Our [tube](#) dimensions are 20.5" long, 2.25" outside diameter, 1.75" inside diameter.

The bottom of the tube is seated to a small wood block cut with a curve (2.25 diameter), and at top attached using a flexible metal hose clamp. That seating block has hinges at one end, so that the tube can be tilted up for loading feedstock (if used for biochar) without the risk of dropping it and re-clamping.



If used for heating water or other liquid, a continuous flow can be achieved by creating a stopper with two tubes for inflow and outflow.

7. How to use:

Make sure you wear protective goggles. The reflector should be pointed due north, to the spot where the sun will be at noon. The mirror rotates from side to side to allow tracking of the sun throughout the day, and can be held in place by string, rope, etc. Focus the reflector on the tube by moving the mirror to the point where light is hitting the tube on all sides.

- To heat water, first prepare a tank and a bucket: the tank to hold cold water above the reflector, and the bucket to catch the hot water below the reflector.
- Attach the cold water container to the long metal pipe in the cap, and the hot water container to the short metal pipe.
- Place the solar tube into the holder by lifting the hinges, sliding it in, and then tightening the adjustable band so that the tube does not move (careful not to overtighten and crack the tube). Then lay the tube on the frame.
- Put the wooden cap with the pipes over the opening of the solar tube.
- Open the valve and allow cold water to flow into the solar tube. When it starts to boil, suck on the hot water pipe until the hot water flows out of the solar tube (careful not to burn yourself!).
- Catch the hot water in a well-insulated container. As hot water exits the tube, cold water will enter from above and the process will repeat.

This system simply uses sunlight to make the solar tube very hot. These instructions describe only one possible use of the system. Try to use this system anywhere you need heat!

8. Measuring temperature

A high temp thermometer can be used to manually measure the temperature:
<http://www.amazon.com/Etekcitey-Lasergrip-Temperature-Non-contact-Thermometer/dp/B00837ZGRY>

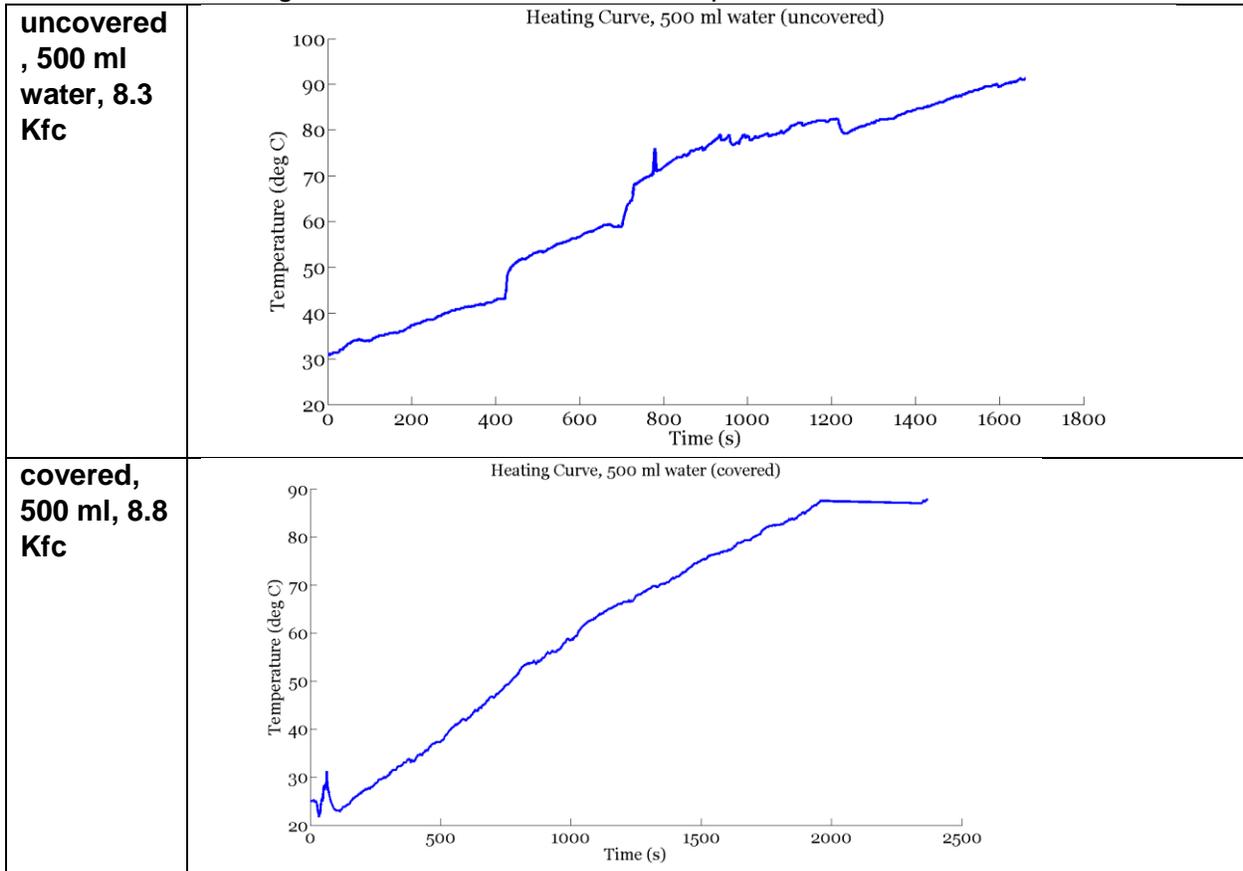
Better, you can automate temp measures with a thermocouple and Arduino:

https://www.adafruit.com/products/270	High temp thermocouple	\$10
http://www.adafruit.com/products/269	Thermocouple amplifier	\$14
https://www.sparkfun.com/products/11021	arduino	\$25

<https://learn.adafruit.com/thermocouple/using-a-thermocouple>

You can open the Arduino IDE, go to "Sketch", "Manage libraries", search "MAX31855", and click "install".

Our results for heating water, with and without a metal plate as the cover, were as follows:



**covered vs
uncovered
empty**

