Cardboard Box Solar Oven

Time needed: 30 minutes + cooking time

(Borrowed and slightly adapted from the New Mexico Solar Energy Association: http://www.nmsea.org/Curriculum/4_6/pizza_box_oven/pizza_box_ovens.htm)

The principles demonstrated are:

Solar Gain — arranging for sunlight to enter a device as a source of energy. In this case, the gain is accomplished both by reflection and direct gain. This principle also includes using dark colored surfaces to absorb the solar energy that enters a device.

Insulation — containing heat by trapping air inside and around a device to contain heat, and reflecting thermal radiation back into a device.

The third principle of passive solar design — *thermal mass* — can also be experimented with the solar oven. Large amounts of food will provide some thermal mass, causing the oven to heat up more slowly. Cast iron cookware can also provide solar mass.

Besides explaining these principles in the process of building and using the ovens, here are several other points you might want to make:

I/ *Cooking food takes a lot of energy!* By using solar energy, we can save a lot on fuel.

II/ *Cooking takes time, and the Sun will change position during that time.* Therefore, somebody, such as a vigilant cook, may need to align the solar oven now and then to keep the sunlight entering. Mechanisms that track the sun and adjust the device automatically are called "heliostats" (like thermostat, but with "helio", which means "Sun", instead).

III/ *Solar ovens have been used for a long time.* In the 1830s, the British astronomer John Herschel used a solar collector box to cook food during an expedition to Africa. Nowadays, one can buy commercial solar ovens, ranging from small single dish units, to large units that can feed many people at once and that have to be hauled around on a trailer.

IV/ *Without the reflector flap, the solar oven becomes what is called a "flat plate collector."* Flat plate collectors are used for many applications, such a heating water (the reason for not using a reflector is that it is not really needed for these applications- and thus alignment difficulties associated with reflectors can be avoided). One of the first known uses of solar hot boxes was by the cooks of the Roman Emperor Tiberius who wanted to eat cucumbers all year round. The cooks satisfied his regal appetite by using a solar hot box, a kind of flat plate collector, to grow the cucumbers all winter long!

Nowadays, many people also use flat plate collectors to heat water for their pools and houses.

The simplest pizza box solar oven design, as given below, can get up to two hundred degrees Fahrenheit on a warm sunny day, enough, for example, to make s'mores. Several optional features will enable the oven to get even hotter, which may be desirable in cooler weather, or for more serious cooking. One should allow ample time for cooking — roughly twice as long as would take in a conventional oven, and for smore's, it works best to leave the sandwiches open while cooking so that direct sunlight falls on the marshmallows and chocolate chips. We do not recommend trying to use the oven outside in temperatures below about 60 degrees Fahrenheit. If it's cool outside, try a sunny window sill.

Materials needed:

1 large size pizza box, or any cardboard box about 16 inches square, and 2-4 inches deep

Several feet of aluminum foil
1 sheet black construction paper
2 1/2 feet of clear plastic oven wrap
masking tape
black water-based nontoxic poster paint
2 feet of string
clear plastic tape

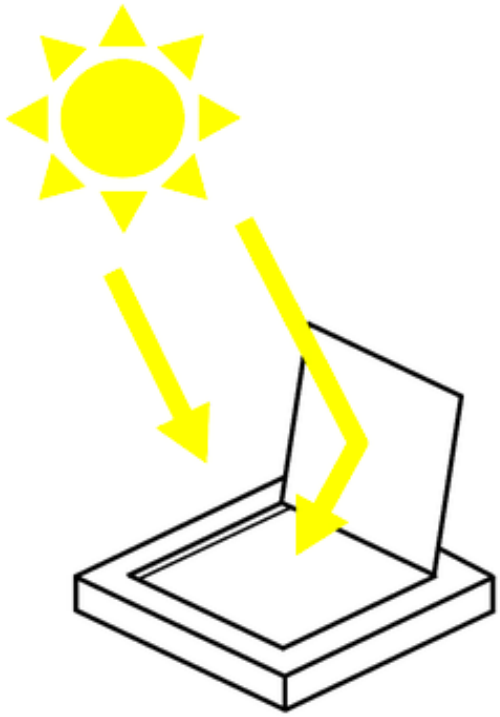
Note: Avoid materials that you think might become toxic when heated.

Tools needed:

scissors (teachers may also want to have a knife on hand to cut cardboard).
ruler
marker
paint brushes, can of water

Step-by-step construction:

Assemble the cardboard box, and open it up.



On the top flap of the pizza box draw a square with a marker with edges spaced 1" from the four sides of the box. Cut along three of the lines, on the sides and on the front edge of the box, leaving the fourth line along the box's hinge uncut. Then fold open the flap, making a crease on the fourth line to form the reflector (see drawing above). Note: Extra supervision may be needed during this step, because students often cut along the fourth line as well by mistake (no problem if you do, you can make a hinge out of masking tape). Now tape aluminum foil to the inside surface of the top flap, with shiny side visible! This will form reflector, to reflect sunlight into the oven. Be careful to make as few wrinkles as possible, and smooth out whatever wrinkles occur.

Paint the inside of the box with the black tempera paint.

Carefully stretch the plastic oven wrap over the opening of the box, sealing the edges with tape to seal the air in.

Cover any air leaks around the box edges with tape, except while making sure that the box can still be opened, so you can place food inside the box and remove it later.

Go outside in the sunlight and place oven on a flat, level surface.

Open the lid, and place food on a paper plate inside the oven.

Use string and masking tape to tie back and adjust the reflector, so that sunlight is reflected into the oven, and especially onto the food.

Let food cook. You'll have to check the reflector angle now and then, and also turn the box to orient it towards the sun, to make sure the maximum amount of sunlight is getting inside the oven.

Solar S'mores recipe:

Put a square of graham cracker down. Press a marshmallow on top of graham cracker. Press a square of chocolate on top. This way the chocolate and marshmallow melt down onto the cracker.

Put in oven to cook. When the marshmallow and chocolate have melted enough, remove from oven and smush another graham cracker square on top. Enjoy your solar treat!

Optional Features:

A. Gather more sunlight: Add additional foil-covered cardboard flaps to reflect sunlight into the oven. This can substantially increase the gain of the oven. This will require some extra cardboard (from some old boxes for example), and some extra foil, glue, and string to adjust the flaps.

B. Improve the insulation: Figure out a way to insulate the box to improve heat retention. You could add layers of corrugated cardboard, or add a layer of crumpled-up newspaper inside the box. What else could improve the insulation and retention of heat?

C. Improve insulation: Add an additional layer of plastic oven wrap across the box opening, but attached to the inside surface of the top flap, such that an air space is created between the layers of wrap (the plastic is bound to stick together in some places, so you could use plastic drinking straws as spacers).

D. Gather better data: Place an oven thermometer in the oven, to measure the temperature. Use the temperature readings to help determine what improves the performance of the oven.