Maria Telkes Solar Cooker

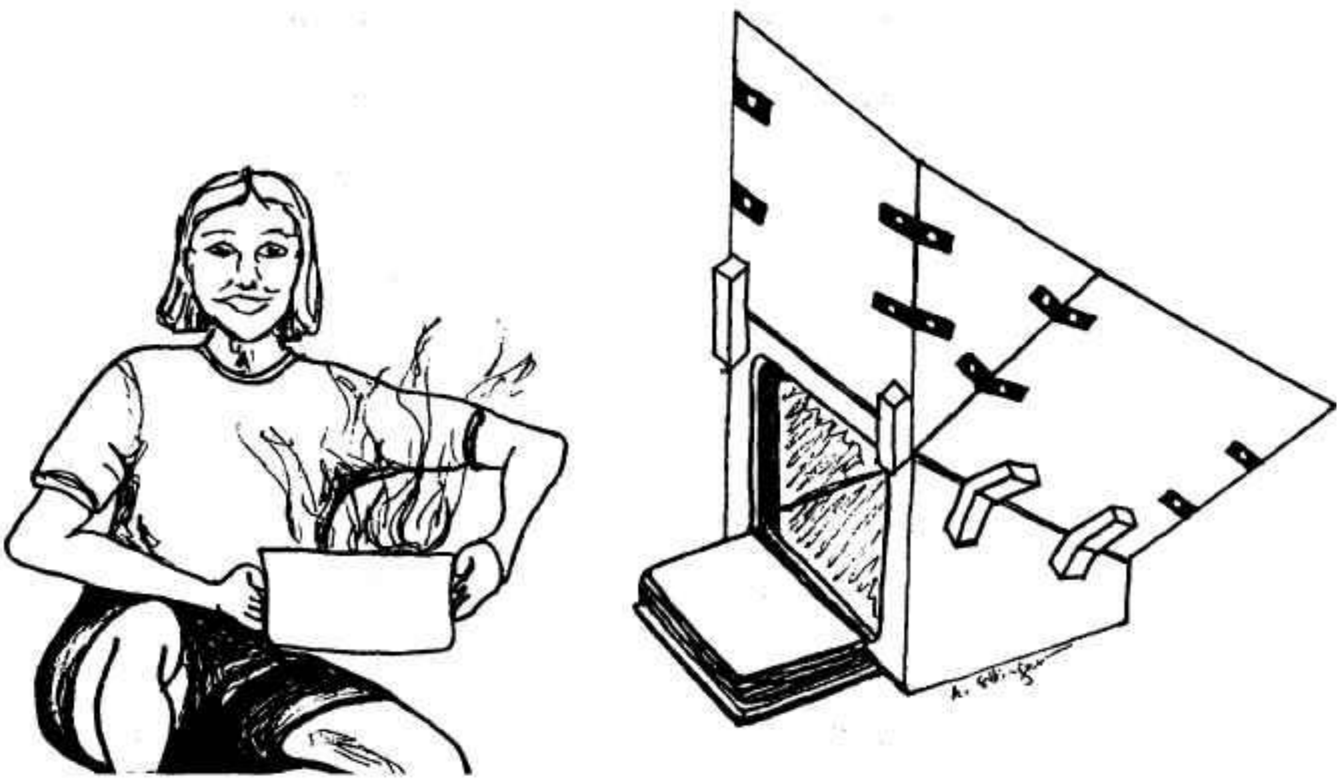
The solar cooker that is recommended was designed and tested by Dr. Maria Telkes during the 1950's. (Dr. Telkes invented many solar devices. She could very easily qualify as the mother of Appropriate Technology.) This oven easily reaches 300 degrees R and will touch 400 R on hot summer days. It isn't necessary to constantly reorient it, because the stove is powerful enough that it works even when it's not aimed exactly at the sun. We recommend building fairly large scale cookers because solar energy is diffuse. It takes a pretty big reflector and glass top to build up the heat and temperatures necessary for easy cooking. (The cooker in these plans has a glass cover 24" x 26"; we also use one with a

glass cover 30" x 30". This particular design is useful in higher latitudes. Directions are given showing how to adapt the design to all latitudes.)

This solar cooker works well because it combines some important design criteria:

ï¿½The box is surrounded by reflectors, which direct visible light down into a box through a glass cover. (On a sunny day, each square foot of earth in sunshine receives about 200-300 btu's of energy per hour. One btu is the amount of energy it takes to raise one pound of water one degree R)

ï¿½The box is well insulated and relatively



Hot food fresh from the solar cooker.

airtight.

ï¿½The glass is at a 60 degree angle, minimizing shading. Double panes of glass help a great deal as the air space in between the panes helps to insulate the box.

ï¿½The box is metal lined and painted completely black so that visible light is efficiently absorbed and changed into infrared or heat energy. The infrared energy is absorbed by the glass and its escape is slowed by the insulation inside the walls, so that heat leaves the box slowly enough that internal temperatures can rise.

ï¿½The pot sits on a black metal floor so that heat enters the pot through conduction (metal to metal contact) as well as through convection (air to metal contact.)

How to Design a Powerful Solar Cooker

Here is one simple way to design a solar cooker that will work well:

Figure out what you will normally want to cook.

Figure out how quickly you need to cook the food.

Figure out how many btu's you need to cook the food. (As a very rough rule of thumb, figure on needing about 150 btu's per hour per pound of food to cook food in "normal" time periods.)

Depending on your latitude, the cooker will receive between 200-300 btu's per square foot per hour. It's about 300 btu's near the Equator and closer to 200 btu's near 45 degrees North and South Latitude. Only approximately 30% of this energy will actually cook the food.

Size your solar cooker accordingly. For example: A solar cooker with a total of 10 square feet of sunlight directed into the box,

has about 2,000 btu's per hour entering the box when used near Aprovecho. The cooker is only about 30% efficient so about 660 btu's will actually cook the food per hour. 660 btu's divided by 150 equals 4.4. Therefore, about 4.4 pounds of an easily-cooked food (including the weight of the water) can be made per hour in this cooker. Hard-to-cook items will require more time. To accomplish this type of powerful cooking, make sure that:

A.) The glass is as perpendicular to the average position of the sun as possible. With the Telkes cooker, aiming the glass directly at the sun will optimize the effectiveness of the reflectors. The maximum amount of sunlight will be reflected down into the box. Take into account whether more cooking is done during the summer or winter.

To figure out the angle of the sun above the horizon, subtract the local latitude from 90. Then add 23.5 degrees to the result. This will give you the highest sun position in the summer. Subtract 23.5 degrees from the result to find the sun's lowest position in winter. For example, the latitude at Aprovecho is 44 degrees north. 90 minus 44 equals 46.46 plus 23.5 is 69.5 degrees. This is the highest point reached by the sun in summer.

46 minus 23.5 is 22.5. The sun only reaches 22.5 degrees above the horizon in the dead of winter. Since Aprovecho does most of its solar cooking in the middle of the summer, we place the glass in the Telkes cooker at 60 degrees. Aim the glass in your cooker at the most advantageous angle.

B.) The reflectors are at 120 degrees to the glass. Another way to say the same thing is that the reflectors are positioned at 30 degrees to the incoming rays of light. The reflectors can be about as long as the glass surface they face. Longer reflectors will only aim sunlight at the opposite reflector. (See diagram A.)

C.) Make the box well insulated, as airtight

How to Construct a Telkes Solar Cooker

Make the box first. Begin by cutting out all of the pieces. In this case we used 1/2 inch plywood.

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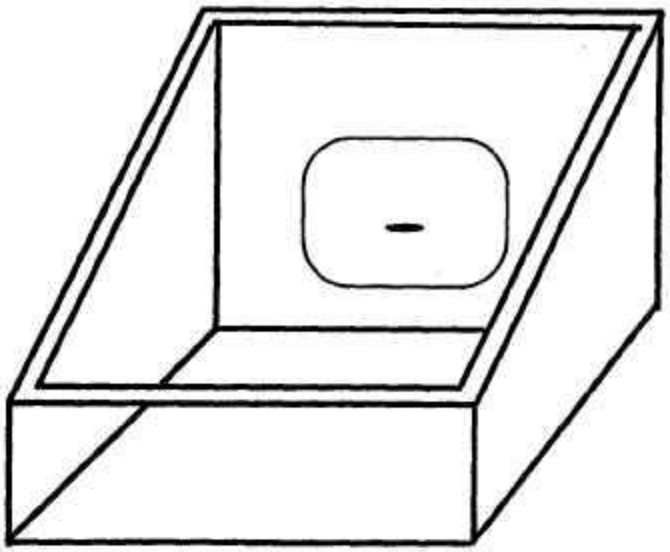
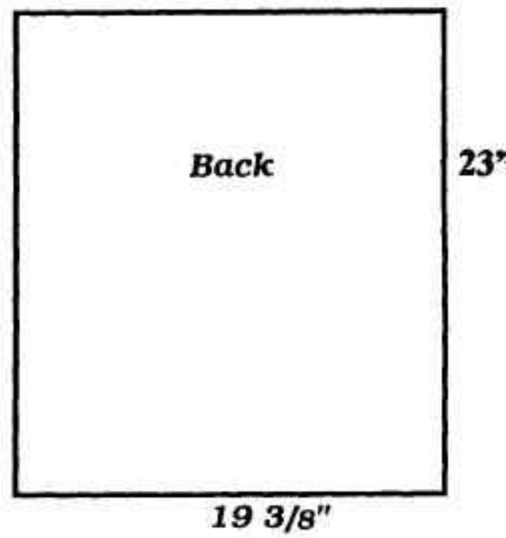
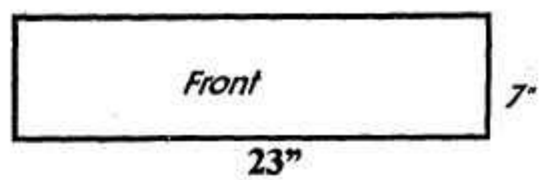
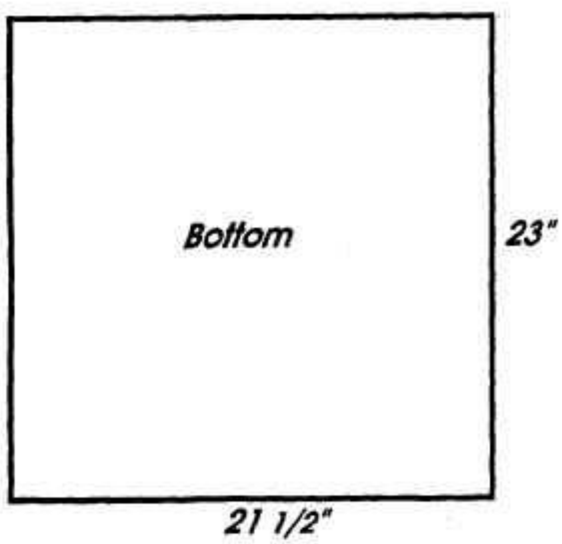
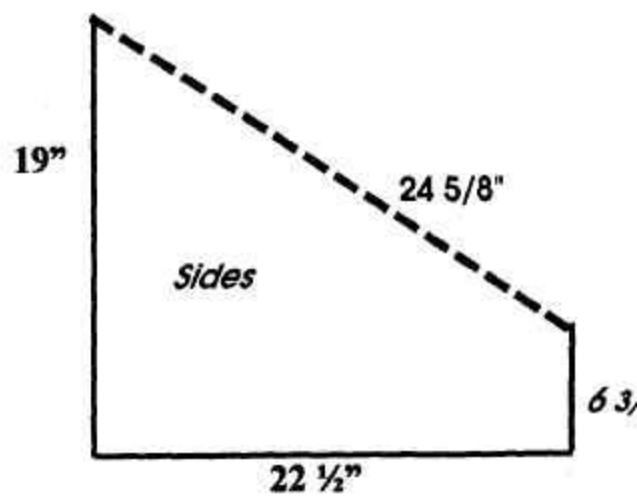


The following diagrams show the sizes of the pieces which make up the box and the reflectors.









as possible and, if economically feasible, use double panes of glass with a small air gap between the two panes to increase the insulative value of the glass cover. This is especially important in cold, windy climates. Insulation made up of cardboard and aluminum foil works well. Good insulators also include wood ash, charcoal, rigid foam, etc. (See notes on insulation in the Rocket Stove section, pp. 20-23.)

D.) In a Telkes type cooker, paint the inside flat black. Have the black pot rest on a black metal floor so that we take advantage of conduction and convection. (Any part of the interior of the box can be shiny instead of black, if sunlight will hit the surface and be directed at the black pot. Then the pot is most efficiently absorbing the solar energy. In some situations, however, shiny interior walls reflect sunlight out of the box through the glass.)

E.) Since hot air rises, the best theoretical place for the door is on the bottom of the cooker. However, this may be difficult. The Telkes cooker has a back entrance door.

F.) Remember that heat and temperature are two different things. Heat is the amount of btu's available for cooking. The internal temperature of the box is only the point in degrees where the amount of heat gained and lost equalizes. It's important to have a high enough temperature and enough heat energy for cooking to occur. A large Telkes model will be a powerful solar cooker. Solar cookers with less square footage of reflector area will cook at lower temperatures, over a longer period of time.

G.) The square footage that is multiplied by 200 to 300 btu's per hour is not the square footage of the reflectors! It is, instead, the square footage of the intercepted sunlight. (See diagram A.) The Telkes cooker is only one of many. But all designs work in the same manner. Each receives the same 200 to 300

btu's per hour depending on latitude. It is easy to figure out in advance how much energy is available in any design for cooking.

The accompanying diagrams show how to build a medium to large Telkes cooker. This cooker is made out of plywood or sheet metal. In the U.S., it's easiest to make the stove from these materials. It is important to remember that a high mass stove body will absorb a lot of heat that could have initially gone into the cooking process. (A heavy pot will do the same. See "Insulation and High Mass in Stoves (and Houses)", pp. 22-23.) A lower mass oven will heat up much more quickly. The higher mass stove will only assist in the cooking process when the pot is cooler than the stove body. It's important to insulate the stove body from the stove interior by using low mass, highly insulative or reflective materials. A solar cooker made from bricks or earth without interior insulation will waste energy in heating up the stove instead of the food. A solar cooker is also relatively low powered so it's usually better to use the energy directly without storing heat for later use.

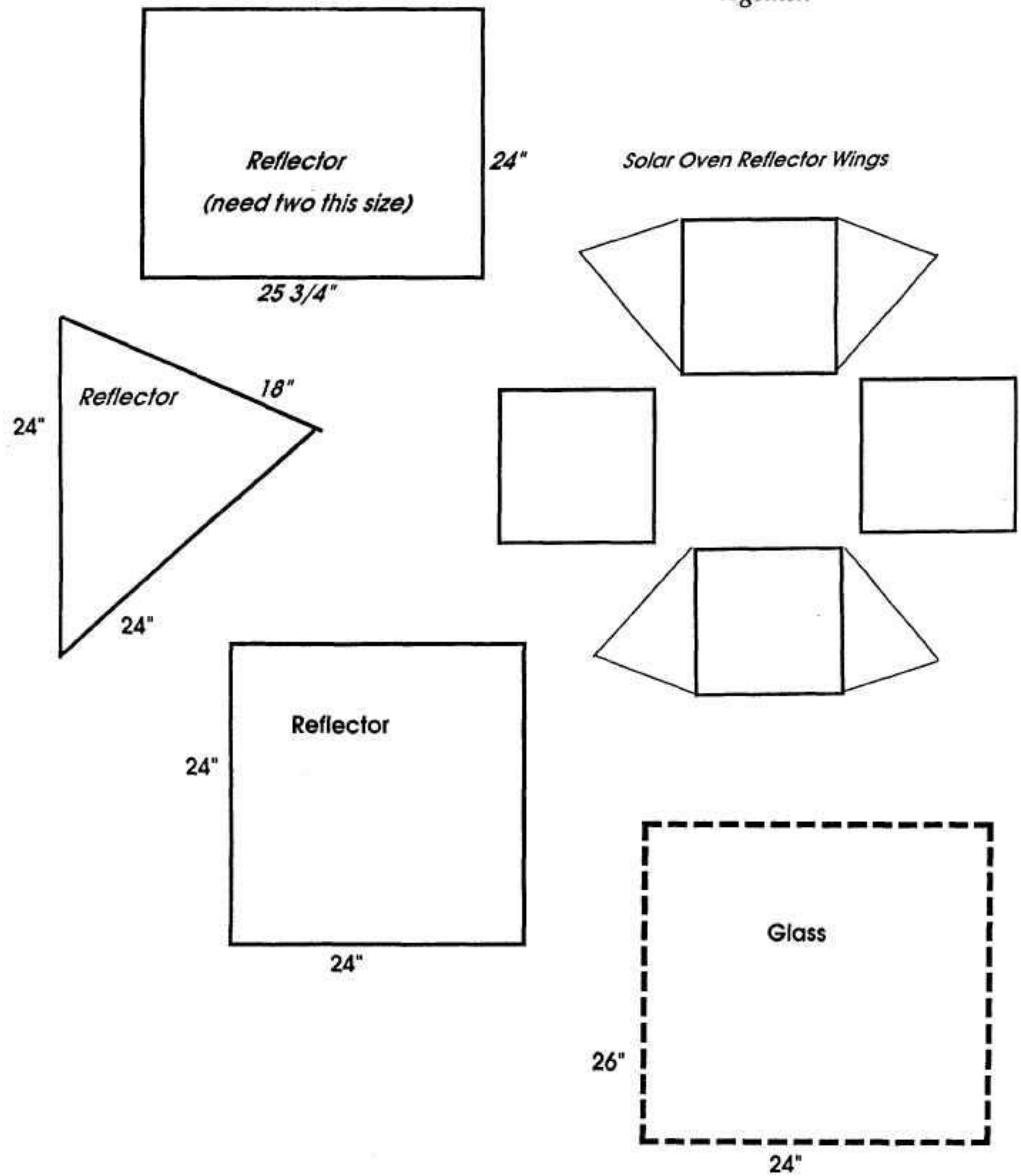
It is also possible to make the body of the stove out of scrap metal, such as metal containers. We are confident that it is quite possible to make both the stove body and reflector from any sort of wired together cans or found metal.

How to Build the Plywood Telkes Cooker

Begin by constructing the box first. In this case we used one-half inch thick plywood. Cut out all of the pieces shown in the diagram. Bevel the edges that meet the glass at 30 degrees. Cut the door into the back or sides of the box. Each joint is glued and nailed together.

The glass cover fits over the plywood and is supported by the insulation as well, which

This diagram shows how the reflector is put together.



completely covers all interior wooden surfaces. You can nail or glue rigid foam insulation to the walls or build up the one inch thick insulation out of alternating layers of cardboard and aluminum foil. If you choose the cardboard option, contact cement works better than white glue. It resists moisture better. Big washers, with nails or screws, are helpful to hold the cardboard to the walls. Remember that the front and back insulation needs to be beveled. Surround the cardboard insulation with aluminum foil, shiny side facing in towards the food. Make this "package" as tightly and strongly wrapped as possible to keep moisture out of the cardboard. Paint the whole interior black with water based flat paint. Leave the cooker in the sun for a couple of days to burn off the gases from the paint before using the cooker.

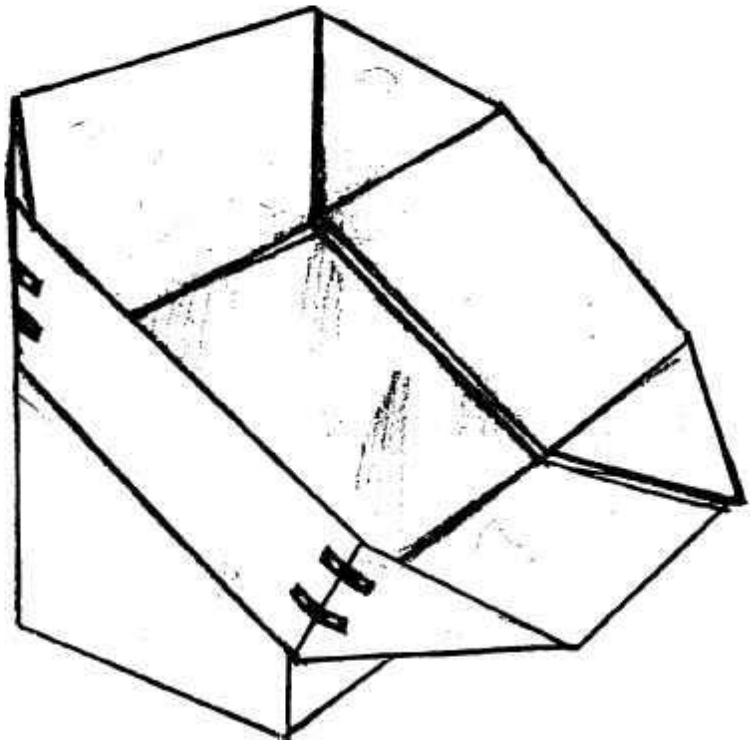
The reflector wings, which in this case are made out of 1/2" plywood, need to be supported by some type of brace. We make the braces out of wood. The reflectors meet the glass at an angle of 120 degrees. Hinges hold the reflectors together. It's possible to make the hinges from leather or old bicycle tubing.

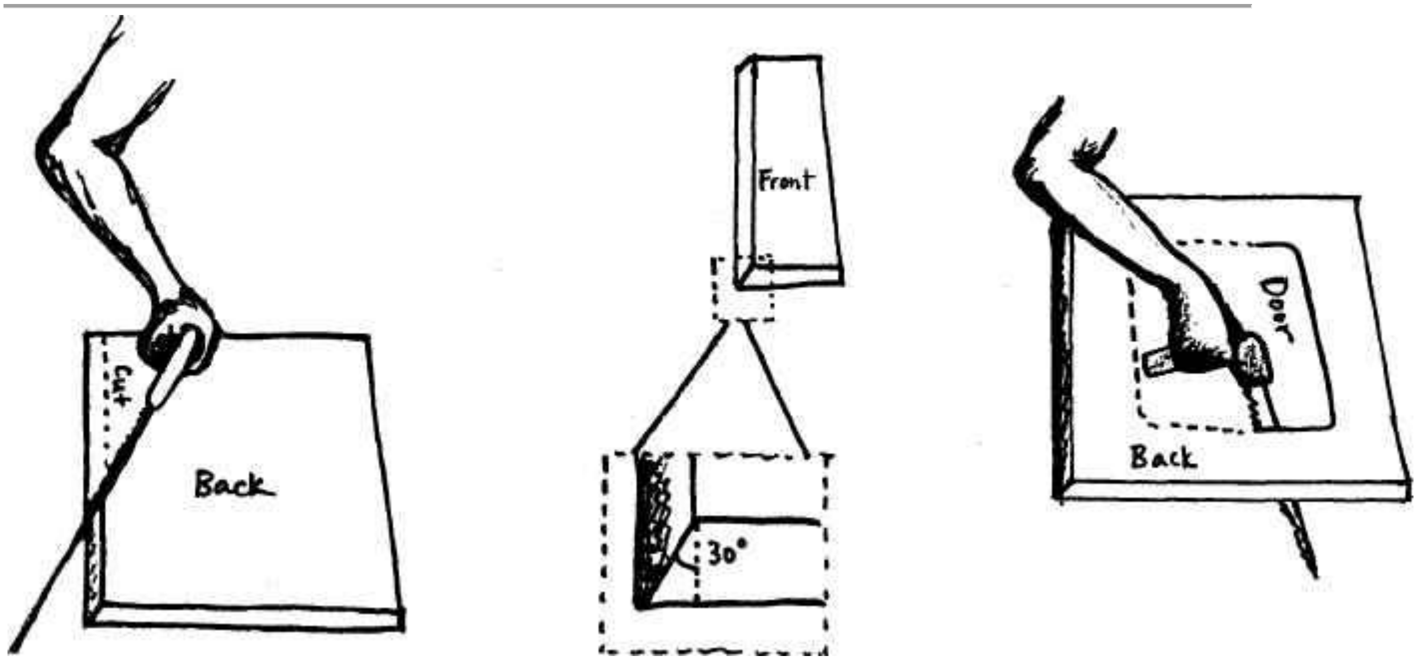
The interior of the reflector needs to be covered with something very shiny like aluminum foil or mylar. Contact cement works well.

The box works better covered with two panes of glass. One pane works too. Glue the glass to the insulation and plywood, using a sealant, preferably silicone. The silicone can also be used as a spacer between the two sheets of glass. Leave a small air hole so that the heated air can escape and not build up pressure between the panes of glass.

Remember that the black pot (hopefully, low mass) should sit on a black cookie sheet or painted piece of metal. Make sure that the door fits tightly, try to minimize air leaks! The oven can't get hot with a lot of air infiltration.

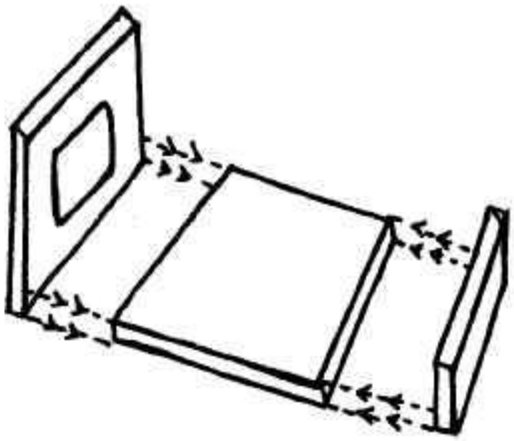
Following these criteria will result in a solar cooker that should hover around 300 degrees F. even when full of food. On hot days, beans will cook quickly, bread will bake and brown, chicken will get crispy and french fries will disappear in foaming oil as they fry. The results will impress you!

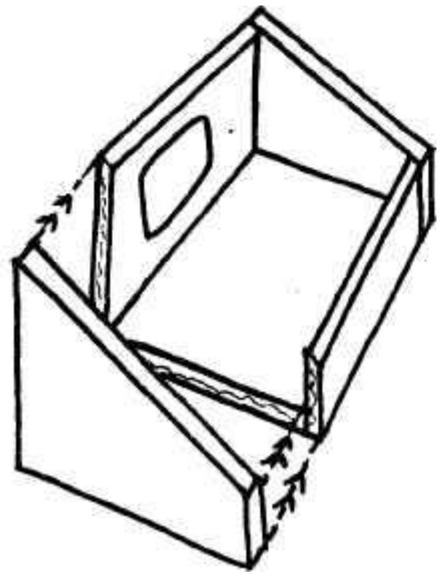




Cut the door out of the back panel.

Remember to bevel the front and back panels at 30 degrees.



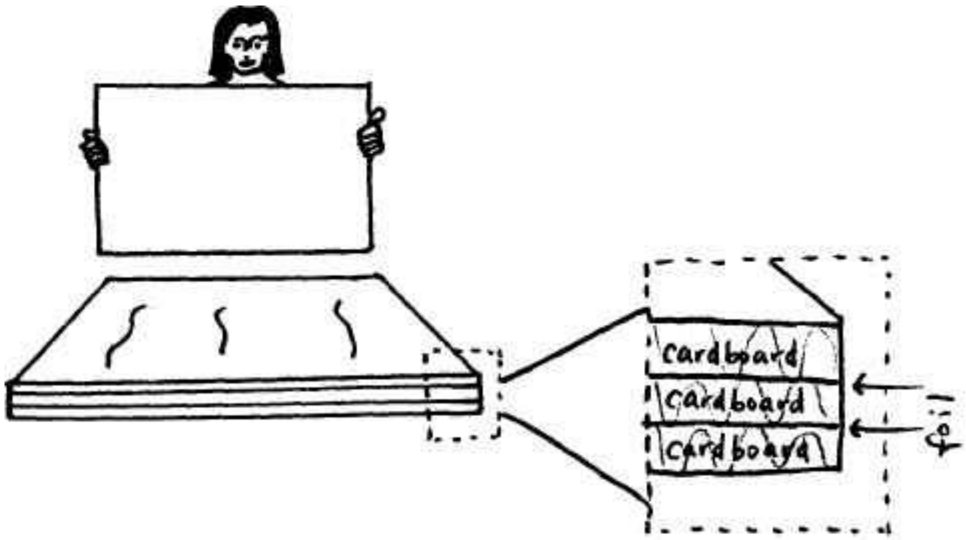


The back and front are nailed onto the

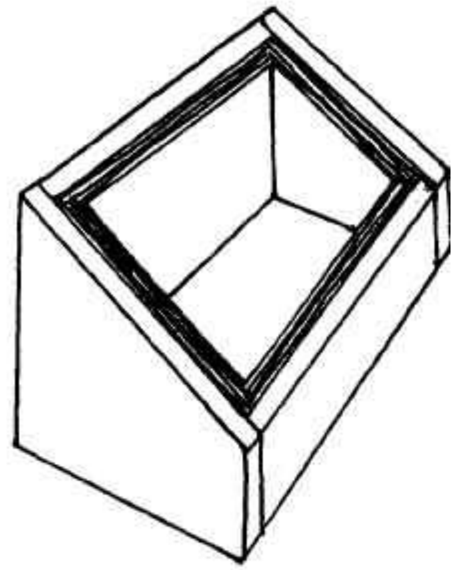
bottom

The sides are nailed onto the bottom, back,

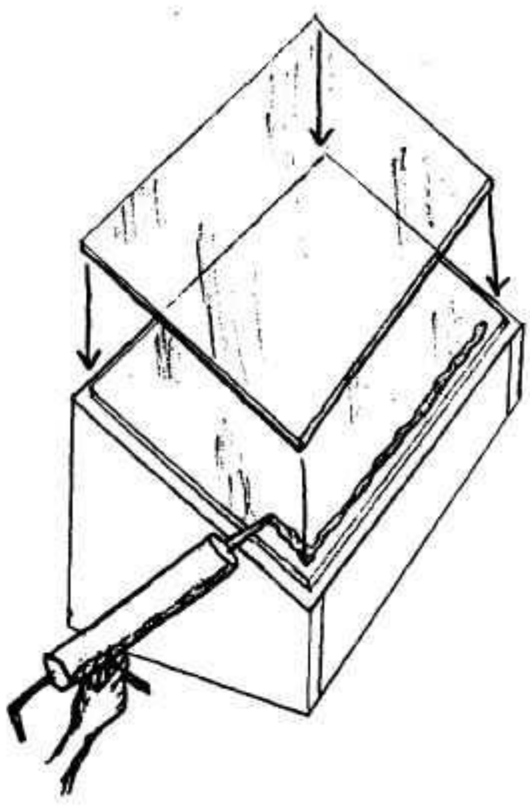
andfront.

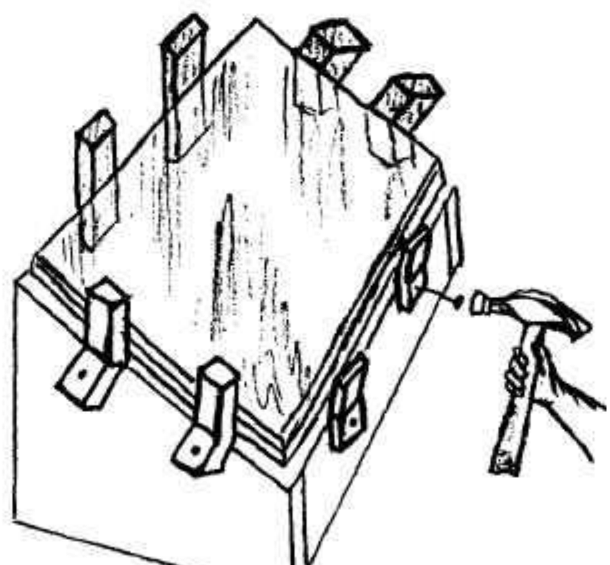


Insulation can be made up of cardboard and aluminum foil.



The cardboard and aluminum foil are attached to the interior of the box using nails and large washers.



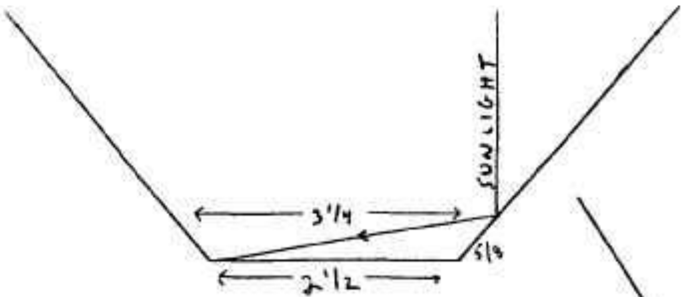


The glass is glued to the top of the box using silicone sealant. If two panes of glass

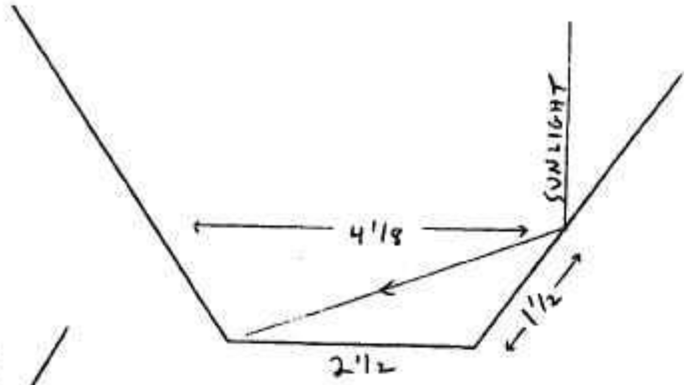
Wooden reflector supports that meet the

are used, another bead of silicone forms a gasket between the two.

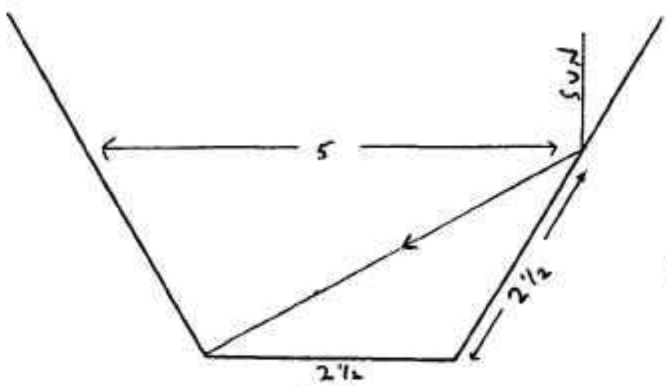
glass at an angle of 120 degrees are screwed or nailed to the box.


SUNLIGHT
3 1/4
5/8
2 1/2

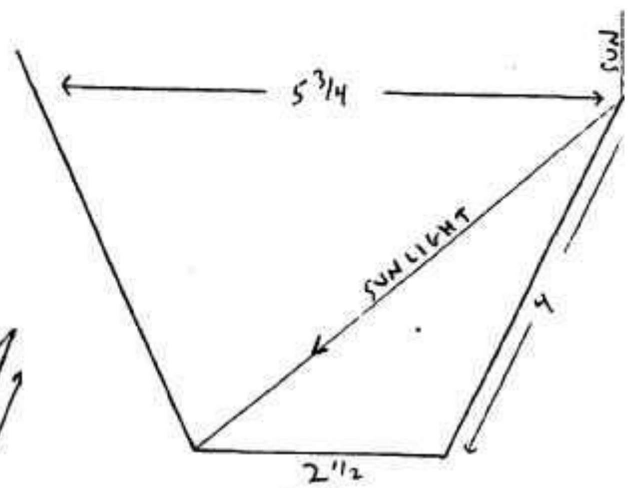
40°


SUNLIGHT
4 1/8
1 1/2
2 1/2

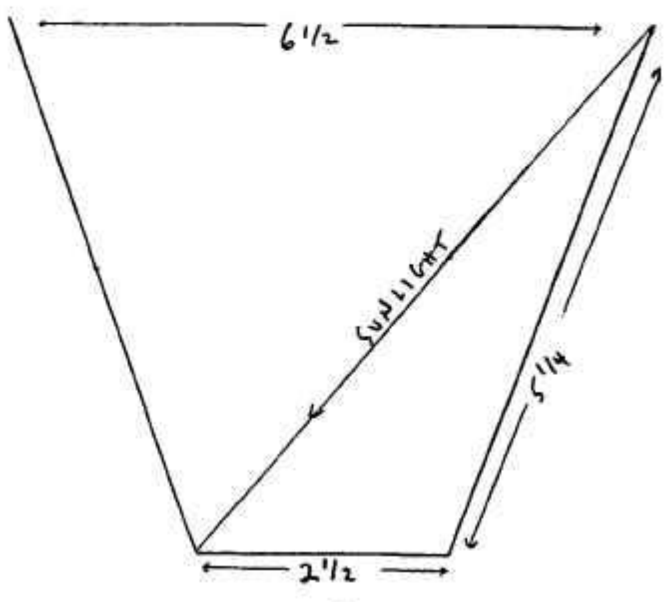
35°


SUN
5
2 1/2
2 1/2

30°


SUN
5 3/4
SUNLIGHT
4
2 1/2

25°


6 1/2
SUNLIGHT
5 1/4
2 1/2

20°

Diagram A: A comparison of varying reflector angles for solar cookers, showing the amount of admitted sunlight and the advantages of a 30 degree angle.