D. SOLAR WATER HEATER

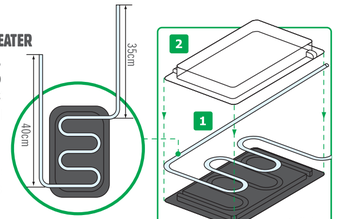
SAFETY WARNING

In strong sunshine, with the Sun overhead, the Solar Water Heater's parts and the water inside could reach 50°C (122°F) or higher. Always handle the water heater with care when it has been in the sunshine. Adult supervision is required.

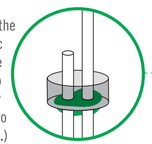
CONSTRUCTING YOUR SOLAR WATER HEATER

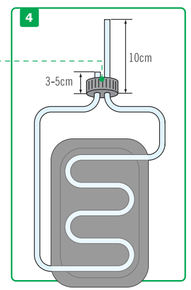
You will need: the black panel base, transparent plastic tube, the cap with two holes, the connector, soft wax, 40°C (104°F) thermal indicator sticker and adhesive tape.

Also required but not included in the kit: one small and one larger plastic drinks bottle.

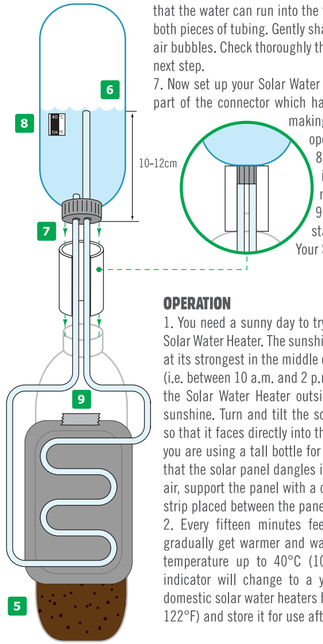


1. Lay the transparent tubing into the groove in the solar panel base as shown in the diagram. Start about 35cm from one end of the tubing so that you finish with about 40 cm of free tubing at the other end. Push the tubing gently into the groove, being careful not to kink the tubing (this will stop the water flowing).
2. Carefully fit the cover over the base.
3. To prevent heat from escaping from the back of the panel, press a folded plastic bag into the recess at the back of the panel. Use the adhesive tapes included to fix the different parts in place. (You may use more adhesive tape from home to further seal the edges for better insulation.)

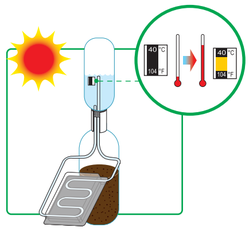




4. Stand the panel upright so that the longer tubing (40 cm long) is at the bottom and the shorter tubing (35 cm long) is at the top. Insert the ends of the tubes through the top of the screw cap with two holes. The longer tube must protrude a little out the other side, and the shorter tube must protrude by about 10 cm. Seal around the holes both inside and outside of the cap with soft wax to make the holes watertight.
5. You need to make a stand for the water storage tank. Fill the larger plastic bottle with water or gravel to make it heavy so that it will not topple over, and screw on its lid. Place the bottle connector around the cap.
6. The smaller bottle acts as the storage tank for the heated water. Fill the bottle about 10-12 cm deep with water. Screw the cap with the tubes inserted in it onto the top of the bottle. Now invert the bottle so that the water can run into the tube. Make sure the water completely covers both pieces of tubing. Gently shake or tap the tube and panel to dislodge any air bubbles. Check thoroughly that all bubbles are gone before moving to the next step.
7. Now set up your Solar Water Heater. Insert the storage tank to the upper part of the connector which has already been install on the larger bottle, making sure that the tubes lead out through the opening slot of the connector.
8. Now stick the 40°C (104°F) thermo indicator onto the smaller bottle surface, just next to the water level.
9. Fix the top edge of solar panel to the bottle stand with an adhesive tape. Congratulations. Your Solar Water Heater is ready to go.

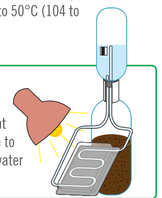


OPERATION



1. You need a sunny day to try out your Solar Water Heater. The sunshine will be at its strongest in the middle of the day (i.e. between 10 a.m. and 2 p.m.). Place the Solar Water Heater outside in the sunshine. Turn and tilt the solar panel so that it faces directly into the Sun. (If you are using a tall bottle for stand, so that the solar panel dangles in the mid air, support the panel with a cardboard strip placed between the panel's back and the bottle stand.)
2. Every fifteen minutes feel the water tank. The water inside should gradually get warmer and warmer. On a sunny day the water will reach a temperature up to 40°C (104°F) within a few hours. The temperature indicator will change to a yellow colour above this temperature. (Most domestic solar water heaters heat water to 40 to 50°C (104 to 122°F) and store it for use afterwards.)

Remarks: If you would like to operate your Solar Water Heater indoors or at a school science fair, you can use a desk lamp with an incandescent light bulb as a source of heat. Do not use an energy-efficient fluorescent lamp as it will not output enough heat. Adjust the lamp so that it is close to the panel and shining straight at it. The simulated "sun" will heat up the water in the system.



HOW IT WORKS

Although only a small set up, your Solar Water Heater demonstrates the working principle of most domestic solar water heaters. The Solar Water Heater heats the water using energy from the Sun. The Sun gives out energy in the form of heat and light. The energy travels through space in rays and some of it hits the Earth. The heat and light that hits the solar panel is absorbed by the black surface of the panel. When the water is cooler than the panel, heat flows into the water, making it warmer. Warm water is less dense than cool water, and so the warmed water rises up the tube into the water tank. Cool water flows from the tank to replace it. This circulation of water continues until all the water is at the same temperature as the panel. In a real solar water heater, the heated water is stored in an insulated storage tank which keeps the water warm until it is used, even if that is at night, hours after the Sun has gone down.

TROUBLE SHOOTING

If the water in the water tank does not heat up:

- The sunshine may not be strong enough. You may have to wait until a hotter day.
- The wind may be cooling the heater. Either shield the heater with cardboard boxes or wait until a less windy day.
- On a cold day, the heat loss from the storage tank to the air could be larger than the heat gain from solar panel, and so the water may not heat up. You can try covering the water storage tank with a small plastic bag that will help to insulate the bottle. Tie the opening loosely around the bottle's neck so that you can easily remove it to feel the water temperature. You can also cover the exposed plastic tubes with plastic food wrap to insulate them.
- Make sure that the solar panel is facing the Sun all the time. Check it each hour as the Sun moves across the sky. Also make sure no shadows fall on the panel.
- Check that there are no bubbles in the tubes. If there are, gently shake or tap the tubes to dislodge them.

FUN FACTS

- The solar panel is black because black materials are good at absorbing heat. A white panel would reflect the heat and light away.
- Your Solar Water Heater works in the same way as a proper domestic solar water heater. A domestic system has a solar panel mounted on a roof with pipes running through it. Heated water from the panel is stored in a water tank indoors.
- Energy from the Sun is called solar energy. It is a renewable source of energy because the Sun will always keep shining.
- The world's largest solar thermal power station is Kramer Junction in California. It provides 150 MW of energy.
- In remote areas of the world, solar energy is used to heat water to pasteurize the water. This makes dirty water safe to drink.
- Solar energy provides only about 1% of the world's energy needs.
- Less than a billionth of the energy the Sun gives out hits the Earth. Even so, this is ten thousand times as much as all the energy we use.

GREEN SCIENCE

SOLAR SCIENCE

Build miniature working models of a solar oven and a solar water heater. Explore the science of solar thermal energy - a green and renewable source of energy.

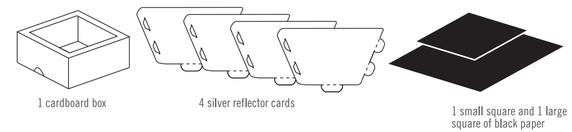
To Parents: Read all instructions before providing guidance to your children.

WARNING:
CHOKING HAZARD - Small parts.
Not for Children under 3 years.
0-3

A. SAFETY WARNINGS

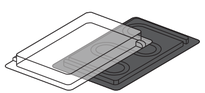
1. Please read through these instructions before you start.
2. Adult supervision and assistance are required at all times.
3. Intended for children of over ages 8.
4. This kit and its finished product contain small parts which may cause choking if misused. Keep away from children under 3 years old.
5. In strong sunshine, with the Sun overhead, the solar oven model and water heater could reach high temperatures. Always handle the devices with care when they have been in strong sunshine. Wear oven gloves to handle the setup if required. Use the models only as described in the instructions.
6. During the experiments, you need to line up the models with the Sun. As you do this, avoid looking directly at the Sun or the reflectors, as this could damage your eyes. Wear a pair of sunglass if required.

B. CONTENTS


1 cardboard box

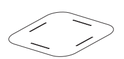
4 silver reflector cards

1 small square and 1 large square of black paper

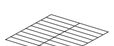

1 black panel base with cover


1 bottles connector


1 transparent plastic tubing


1 transparent plastic cover sheet

1 cap with two holes


Adhesive tape


2 thermal indicator stickers, printed 70°C (158°F) and 40°C (104°F)

1 soft wax

Also required but not included in the kit: an oven thermometer (a room temperature thermometer is not appropriate because temperatures inside the oven may be too high), aluminium foil, a small zip-lock bag, a piece of cheese or chocolate, a small egg, one small and one larger plastic drinks bottle.

C. SOLAR OVEN

SAFETY WARNING

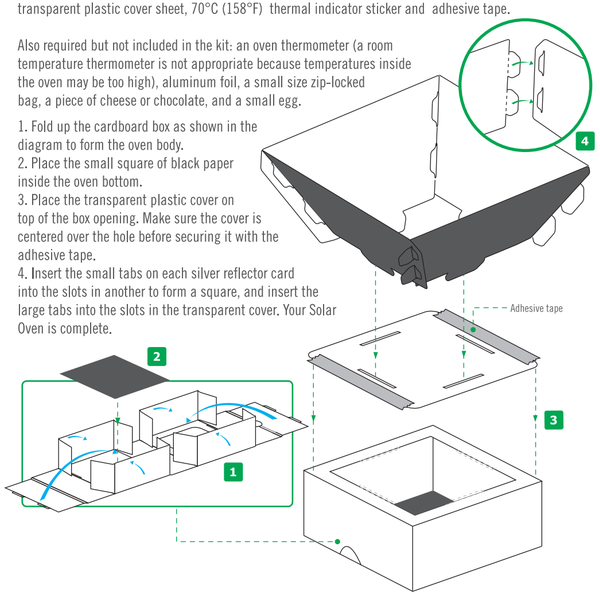
1. In strong sunshine, with the Sun overhead, the solar oven model could reach 100°C (212°F) or higher. Always handle the oven with an oven glove when it has been in the sunshine. Adult supervision is required.
2. Use the model only as described in the instructions. The model is designed for experimental demonstration only. It is not a cooking device. Do not eat the food heated or cooked inside as it may not be thoroughly cooked.

BUILDING YOUR SOLAR OVEN

You will need: cardboard box, 4 x silver reflector cards, small and large squares of black paper, transparent plastic cover sheet, 70°C (158°F) thermal indicator sticker and adhesive tape.

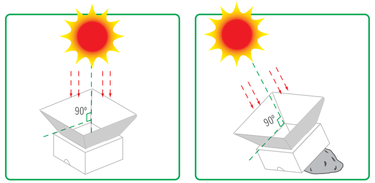
Also required but not included in the kit: an oven thermometer (a room temperature thermometer is not appropriate because temperatures inside the oven may be too high), aluminum foil, a small size zip-locked bag, a piece of cheese or chocolate, and a small egg.

1. Fold up the cardboard box as shown in the diagram to form the oven body.
2. Place the small square of black paper inside the oven bottom.
3. Place the transparent plastic cover on top of the box opening. Make sure the cover is centered over the hole before securing it with the adhesive tape.
4. Insert the small tabs on each silver reflector card into the slots in another to form a square, and insert the large tabs into the slots in the transparent cover. Your Solar Oven is complete.

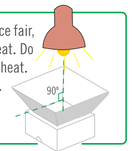


SETTING YOU SOLAR OVEN

For the maximum heating effect, you need to place your Solar Oven under the midday Sun (i.e. between 10a.m. and 2p.m.) on a clear, sunny day. As the Sun moves across the sky during the day, You will also need to tilt the oven so that the sunshine shines straight into the oven (use a stone to support one side of the box). Turn the oven as the Sun moves across the sky.



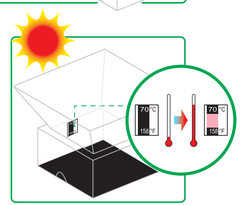
Remarks: if you would like to operate your Solar Oven indoors or at a school science fair, you can use a desk lamp with a 60W incandescent light bulb as a source of heat. Do not use an energy-efficient fluorescent lamp as it will not produce enough heat. Adjust the lamp so that it is close to the oven opening and shining straight at it. It will act as a simulated sun and heats up the oven. Adult supervision is required when using a desk lamp.



EXPERIMENTS

1. Measuring the oven temperature

Stick the thermal sticker marked 70°C (158°F) onto an inside wall of the oven so that you can still see it from the outside (do not stick it on the black paper at the bottom as the paper's temperature is always higher than that of the air). Put the oven in the sunshine. After a while the indicator will change colour to pink, showing that the temperature has risen above 70°C (158°F). You could make a record of the time this takes on different days. Use the chart below to record your results.



Date	Time	Outside Temperature	Weather Condition	Time required to reach 70°C (158°F)	Remarks

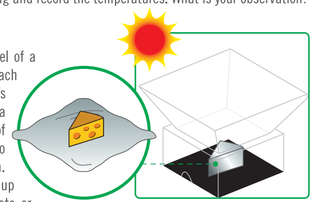
The indicator only indicates if the temperature is over 70°C (158°F). Your Solar Oven could reach higher temperatures in strong sunlight. If you would like to test this, you will need to use an oven thermometer placed inside the solar oven. You can use a chart like this to record the temperature every 15 minutes as the oven warms up.

Date		
Weather Condition		
Outside Temperature		
Time	Oven Temperature	Remarks

Place the oven thermometer inside a zip-lock bag and record the temperatures. What is your observation?

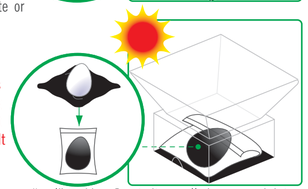
2. Heating food

Although your Solar Oven is just a small model of a real solar oven, the temperature inside could reach 70°C (158°F) or higher on a sunny day — that's high enough to melt some types of food. Place a piece of cheese or chocolate on a piece of aluminium foil, and wrap the foil over the food to form a packet. Place the packet inside the oven. Put the oven in the sunshine (see setting up instructions above). After a while the chocolate or cheese should become soft.



3. The egg cooking experiment

Warning: Do not eat the cooked egg from this experiment. The Solar Oven may not cook the egg evenly or thoroughly, and an uncooked (or soft boiled) egg may contain harmful bugs. Adult supervision is needed.



You can also use your Solar Oven to demonstrate some “real” cooking. Due to its small size, your miniature oven is ideal for demonstrating how an egg can be cooked by sunshine. Wrap a small egg in the large square black paper provided. If your egg has been in the fridge, leave it somewhere at room temperature for a while as a cold egg will require a longer cooking time, and dry the egg shell to get rid of any condensed water. Place the egg into a small zip-lock bag, place the bag into the oven and put the oven in the sunshine. If you are using an oven thermometer, you can watch the temperature rise. On a day with hot sunshine, the egg should be cooked to a “soft boiled” state in 3 or 4 hours.

Try to improve your Solar Oven so that an egg can be cooked more thoroughly and more quickly. You can enlarge the reflector with aluminium foil so that more of the Sun's energy is collected. Or you can add insulation so that more heat is retained inside the oven. For example, you could cut a square opening (slightly larger than the oven body) in one side of the package box, and place the oven into the openin.

The space between the oven and the package box will act as a layer of insulation. Try to think of other ways of insulating the box and compare the eggs "cooked" in the non-insulated and insulated ovens.

HOW DOES YOUR SOLAR OVEN WORK?

Your Solar Oven works by collecting and concentrating heat rays from the Sun. All rays that hit the shiny collector are reflected down into the oven, heating the oven's inside. The black paper absorbs heat that hits it, which helps to warm the air inside the oven. Because the collector covers an area greater than the oven body, the Sun's rays are concentrated in the oven. Food inside the oven is warmed by rays that hit it, and by hot air inside the oven. The food absorbs the heat, which makes it cook. Although quite small, your Solar Oven demonstrates the working principles of a real working solar oven or solar cooker, some of which can reach temperatures high enough to bake a cake or cook a meat steak.

TROUBLESHOOTING

If your solar oven does not heat up:

- Check if there is enough sunshine. The Sun is at its hottest in the few hours around midday - so from about 10 a.m. to about 2 p.m. .Try the experiments during these hours. Or try it again on a sunny day.
- Make sure that the top of the oven is facing the Sun directly so that the oven can collect the maximum number of rays. And remember to adjust the position of the oven as the Sun moves across the sky.
- Avoid doing the experiments on cold or windy days as the air will remove heat from the oven.
- You can also seal the edges of the oven box with sticky tape or wrap the whole oven body in kitchen food wrap. This will help to prevent hot air escaping.

FUN FACTS

- A solar cooker/oven is a simple reflecting device that collects heat from the Sun and focuses it onto food to cook the food.
- There are many different designs of solar cooker/oven. They all work in a similar way, by collecting and concentrating heat rays from the Sun. The larger the collector, the more heat it collects, and the hotter the temperature inside.
- Solar cookers/ovens work best all year round in the tropics. Here, the Sun shines strongly from overhead every day. Near the Earth's poles, the Sun is normally low in the sky and its heating effect is much weaker.
- Some solar cookers are saucer-shaped, with a shiny inner coating. Heat is concentrated into the bottom of the saucer where the food is cooked.
- Solar cookers/ovens are good for the environment because solar energy is renewable. They are also very useful in remote areas of the world, where there is no mains electricity and fuel is scarce and expensive.
- A solar concentrating power station uses a vast array of mirrors to capture and concentrate heat. The heat is used to boil water to make steam, which drives turbines, which drive electricity generators.

Questions & Comments

We value you as a customer and your satisfaction with this product is important to us. If you have comments or questions, or you find any part of this kit missing or defective, please do not hesitate to contact our distributor in your country. You will find the address printed on the package. You are also welcome to contact our Marketing Support Team: Email: infodesk@4m-ind.com, Fax (852) 25911566, Tel: (852) 28936241, Web site: WWW.4M-IND.COM