

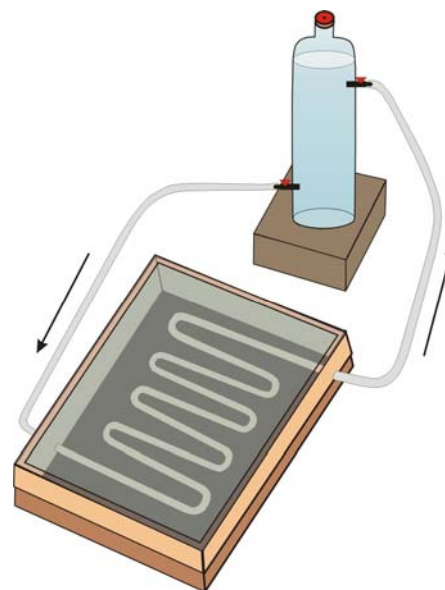
Constructing a simple solar water heater with a collector and a bottle tank

Solar water heaters appear to be a widespread technology in Greece, where roughly 30% of the solar collectors amongst E.U. countries are set up on the roofs of houses, hotels factories, etc. This fact makes children very familiar with solar water heaters, increasing their interest to learn more about them.



Materials

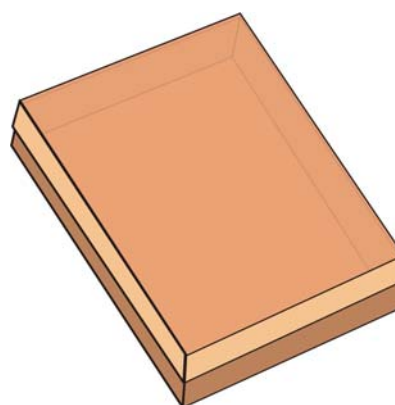
- ✓ a shallow parallelepiped box with a lid, out of a shirt box or any other box with a lid, roughly 30x25x10 cm or bigger
- ✓ approximately 3 m of soft plastic tube 14-16mm inner diameter, either cheap transparent to be painted black or original black tube used as watering pipes in the fields
- ✓ 2 or 3 plastic pipettes with an end tube matching a 14-16 mm pipe, the ones used in order to drill a whole and connect a piece of thinner tube with a bigger main tube for watering purposes in the fields
- ✓ black tempera or black plastic paint & some aluminum foil
- ✓ an empty plastic soda bottle with its top
- ✓ a piece of plexiglas or plain glass
- ✓ some wire and some silicone
- ✓ a piece of polystyrene and some tooth sticks
- ✓ scissors, cutter, ruler, pen or pencil



Let's put it together

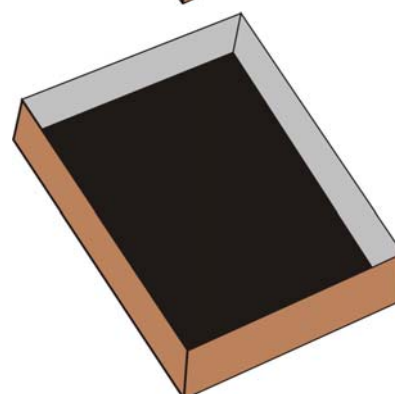
- 1** Find a shallow parallelepiped box with a lid, out of a shirt box or any other box with a lid, roughly 30x25x10 cm or bigger.

Be sure it is a strong box, in order to handle the plastic tube inside it. Otherwise, enhance the sides and the bottom of the box by gluing extra pieces of carton or corrugated paper.



- 2** Paint the inside of the box with black tempera or non-toxic black plastic paint, the bottom and the sides of the box.

Alternatively, you may paint the bottom black and glue aluminium foil at the sides for more reflections inside the box.



- 3** Insert the plastic tube inside the box from it down right side. Set the tube in a continuous “S” shaped mode, creating a serpentine like arrangement. Exit the tube from the upper left side of the box (see drawing).

You will need to tie the tube at the bottom of the box in order to keep it always in the right serpentine arrangement. For this purpose you will have to drill holes in pairs, one above and one below the tube, in all of its length fixed at the bottom of the box. Then, you use some wire to tie the tube. Later, you may need to seal the holes with glue or stick a piece of corrugated paper on the outside back of the box, also achieving better insulation.

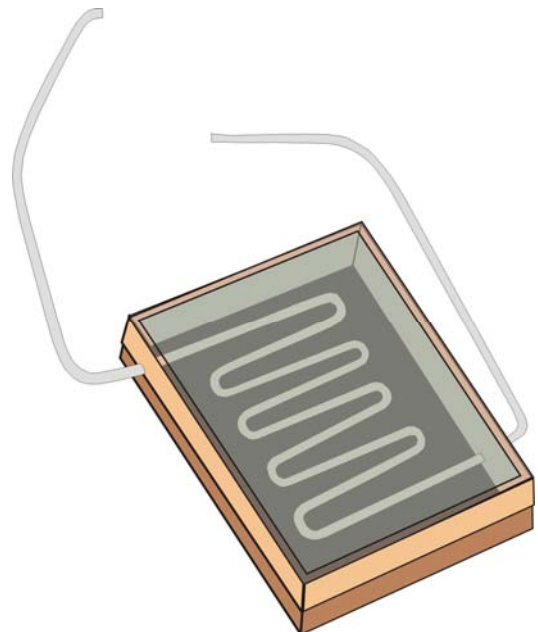
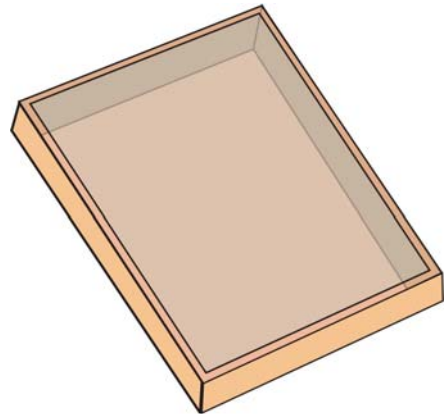
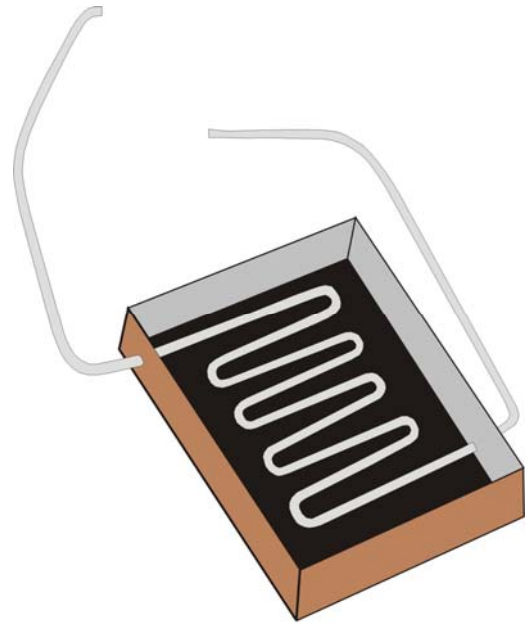
You may use black tube or paint the tube black after you set it up in the box.

- 4** You draw a frame on top of the box lid roughly 2-3 cm from its edges. Use a cutter to take out that frame.

Glue with silicone a piece of Plexiglas or plain glass inside the lid, covering the opening from the extracted frame.

- 5** Put the lid on top of the box with the tube arrangement.

The collector is now ready to be connected to a sort of tank to complete the construction of the solar water heater.

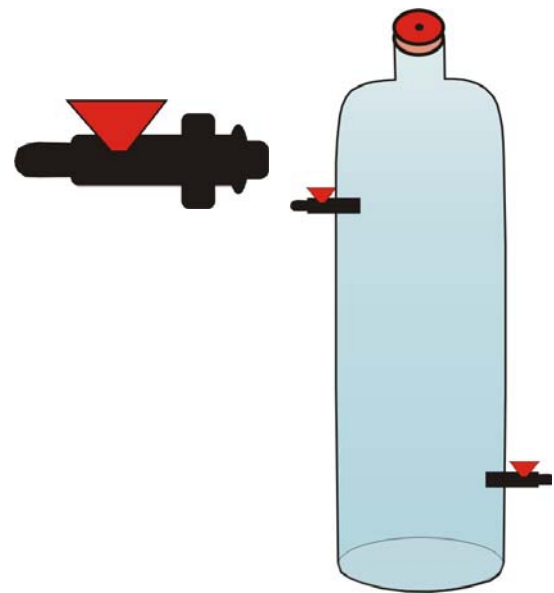


- 6** An empty soda bottle or any other similar plastic container can be used as a tank for the solar water heater.

It is important to find a way to connect the tubes to the tank avoiding water leaking. One way is to use appropriate pipettes used to branch bigger plastic pipes for watering gardens and fields (*see left drawing*). The tube has to match the one end of the pipette.

Use two pipettes, one 5 cm from the bottom of the bottle and one 5 cm from the top of the bottle (*see right drawing*).

Additionally, you may glue the pipettes with silicon on the sides of the bottle to avoid possible water leaking. The water tank is now ready.

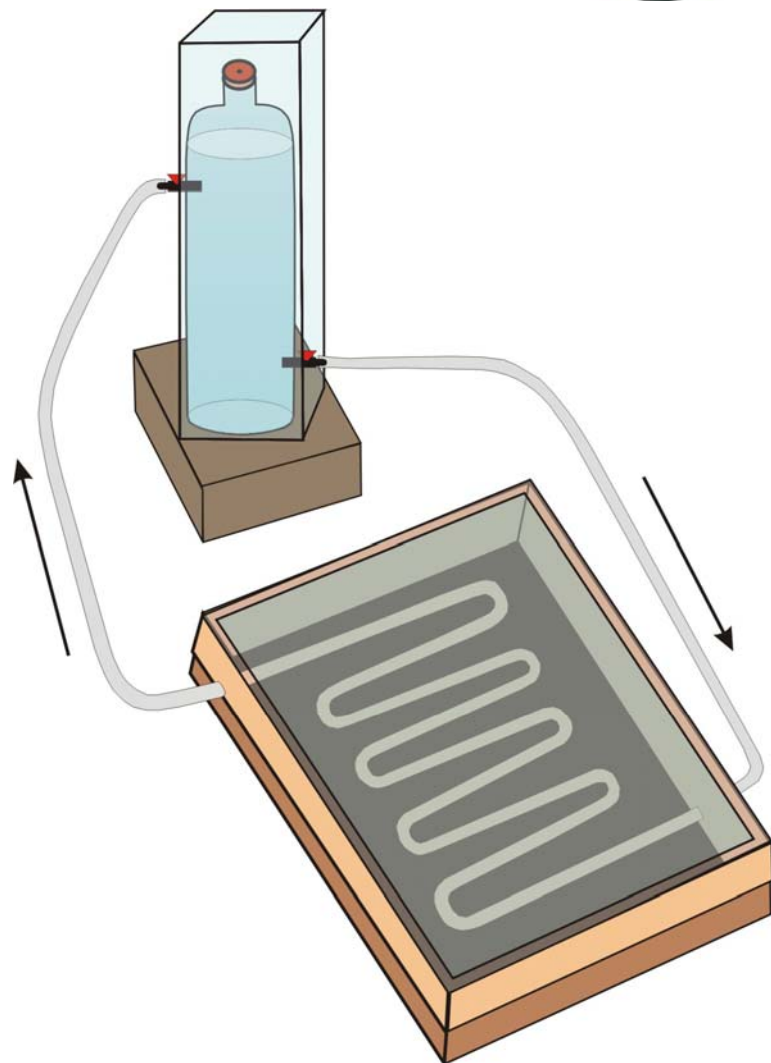


- 7** We connect the lower input tube part of the collector with the lower pipette of the bottle-tank. Then the higher output tube part of the collector with the higher pipette of the bottle.

Do not forget to drill a small hole at the bottle top to avoid troubleshooting air pressure inside the bottle.

You may insulate the bottle-tank by cutting and assembling a box with polystyrene frames and self sticking scratch (*see drawing*).

In simple solar water heaters such as this one, functioning in a rather mechanical way, with the aid of the gravitational field, we actually take advantage of the **thermosiphon effect**, where the heavier (more density) cold water coming from the bottom of the tank is pushing the water heated inside the collector which becomes lighter (less density) and climbs up back to the tank to start over the cycle again and again ...



Appendix

Photos from the construction of a bigger serpentine solar water heater, with children at school. We had constructed a box out of polystyrene, which became the solar heater collector ...



Photo 1: Inserting the black plastic tube inside the collector box made out of polystyrene ...



Photo 2: Arranging the tube and tying it with pieces of wire ...



Photo 3: Tying the tube in its place, forming a serpentine or continuous "S" arrangement ...



Photo 4: Cutting out a piece of corrugated paper to form the top lid of the solar collector ...



Photo 5: Gluing the flaps of the lid ...



Photo 6: Painting the lid and then the collector ...



Photo 7: The testing of a “serpentine solar heater” constructed with flexible black tube, inside a collector box and a plastic can used as a water tank.



Photo 8: Final presentation of the “serpentine solar heater” in a science fair, with an improved incline for the serpentine loops, an improved water tank and some coloring

Nearly in all cases children have to resolve construction problems, which can even make their devices inefficient, as in the case of the “serpentine solar water heater”. When we had initially constructed that solar water heater we were very pleased and left it in the sun for an hour or so in a morning session. Surprisingly enough, the water got hot inside the tubes and we could feel that, but we did not have the “*thermosiphon effect*”. That is, the water did not circulate from the plastic tank inside the collector and back to the tank again, due to the density difference the cold water has compared to the hot. It took us quite a while to find out that we had our water tank, the plastic can, tapped with its lid and that had some air trapped inside, the pressure of which created difficulties in water circulation. The problem was resolved as soon as we drilled a small hole in the lid of the can to equalise the pressures. One more thing we did to improve our model was to make the serpentine incline more steep avoiding the initial “curvy loops”, which “created problems in the circulation of water” because it appeared to stay within these curved parts of the tube longer, trapped in a way. The improved model was presented in a science fair was constructed accordingly in order to “ease the way of the hot water climbing up the tube” towards the water tank (see Photo 7, compared to Photo 8).