

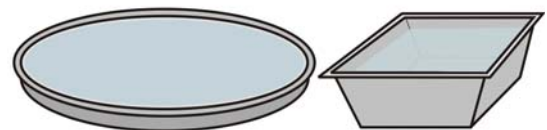
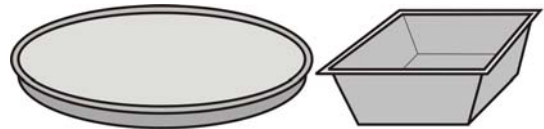
Experimenting with simple solar collectors out of aluminium containers of various sizes

Heating up water in aluminium containers of various sizes and shapes, left out in the sunshine for a period of time, can be a rather interesting and educational set of activities. The aluminium containers are available in round shapes, used for various sizes of pizzas, as well as in parallelepiped or even cuboid shapes, used for packing food in restaurants. They are also cheap and easy to find in supermarkets. They can be filled up with certain amounts of water, covered with plastic films on top or even with pieces of Plexiglas, painted black inside or not and then left in the sunshine for testing and inquiry-based investigations. If the experiments are conducted out in the school yard, it is better to put pieces of Styrofoam under the aluminium containers for insulation with the ground. Moreover, whatever experiment you do, always remember to do a "fair experiment". That is, take care of what you keep the same and what you change, in order to be able to observe and measure accurately and eventually arrive at reliable conclusions.



Materials

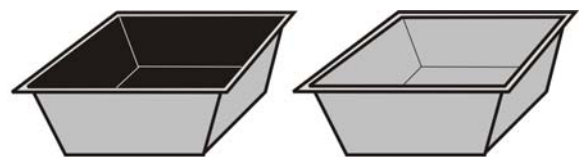
- ✓ several aluminium containers of round, parallelepiped and/or cuboid shapes
- ✓ a roll of plastic kitchen film used for wrapping up food and/or pieces of plastic film or transparencies
- ✓ alternatively, pieces of Plexiglas to cover the top of the various aluminium containers in use
- ✓ flat, non-toxic black paint, to paint some of the aluminium containers inside
- ✓ scissors, cutter
- ✓ ruler, pen or pencil



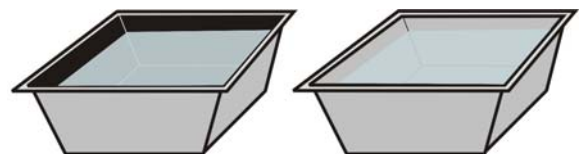
Let's set it up

- 1** Take two parallelepiped and/ or cuboid aluminium containers with the same dimensions and paint the interior of one of them with black non-toxic paint.

Leave it to dry for a while, preferably outside.

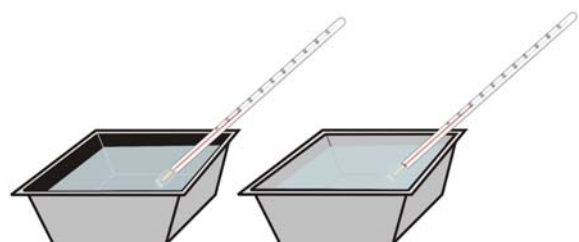


- 2** Put the same amount of water in each container, 300 ml for example and leave them both in the sunshine for 30 minutes or so (*see drawing aside*).



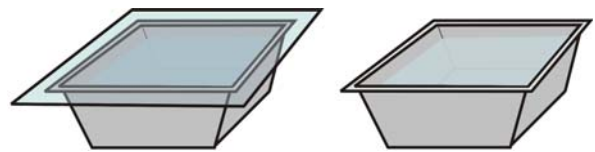
- 3** Take water temperature measurements every 5 minutes using two alcohol thermometers (*see drawing aside*). You may use the indicative table below to record your measurements.

What do you observe? How does the temperature increase in the black painted container and how in the other one? Record and compare your measurements.



	start	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.
water in the unpainted container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C
water in the black painted container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C

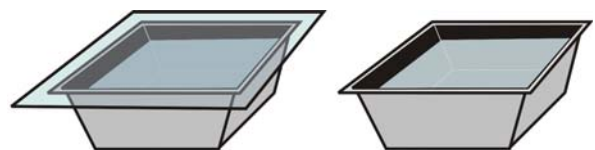
4 Take two parallelepiped aluminium containers with the same dimensions and put the same amount of water in each one, 300 ml for instance. Then, use a piece of plastic film and/or Plexiglas to cover one of the two containers on top. Take them out and leave them in the sunshine for half an hour or so.



What do you observe? How does the temperature increase in the covered container and how in the other one? Record and compare your measurements. You may use the indicative table below (*see drawing aside*).

	start	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.
water in the open container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C
water in the covered container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C

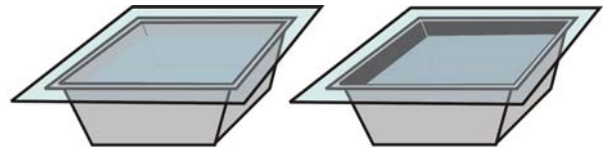
5 Take two parallelepiped aluminium containers with the same dimensions and paint them both black inside, using non-toxic black paint. Leave them to dry for a while and then put 300 ml of water in each one. Then, use a piece of plastic film and/or Plexiglas to cover one of the two containers on top. Take them outside and leave them in the sunshine for half an hour or so (*see drawing aside*).



What do you observe? How does the temperature increase in the covered container and how in the other one? Record and compare your measurements. You may use the indicative table below.

	start	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.
water in the open black container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C
water in the covered black container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C

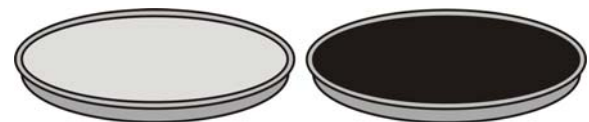
- 6** Take two parallelepiped aluminium containers with the same dimensions and paint one of them black inside, using non-toxic black paint. Leave it to dry for a while and then put 300 ml of water in both of them. Use two pieces of plastic film and/or Plexiglas to cover both containers on top. Take them outside and leave them in the sunshine for half an hour or so (*see drawing aside*).



What do you observe? How does the temperature increase in the black and covered container and how in the unpainted and covered one? Record and compare your measurements. You may use the indicative table below.

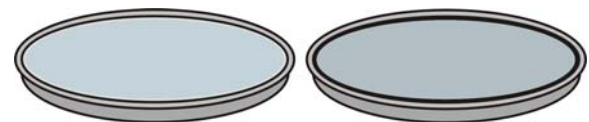
	start	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.
water in unpainted covered container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C
water in the black painted & covered container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C

- 7** Take two round aluminium containers, mostly used for pizzas, with the same dimensions and paint the interior of one of them with black non-toxic paint.

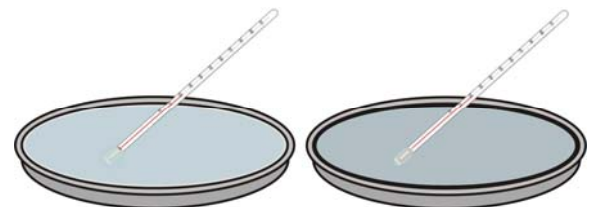


Leave it to dry for a while, preferably outside.

- 8** Put the same amount of water in each container, 100 ml for example and leave them both in the sunshine for 30 minutes or so (*see drawing aside*).



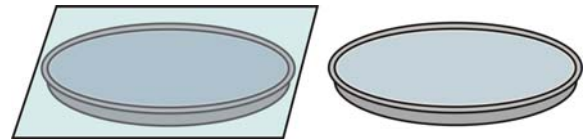
- 9** Take water temperature measurements every 5 minutes using two alcohol thermometers (*see drawing aside*). You may use the indicative table below to record your measurements.



What do you observe? How does the temperature increase in the black painted container and how in the other unpainted one? Record and compare your measurements.

	start	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.
water in the round unpainted container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C
water in the round black painted container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C

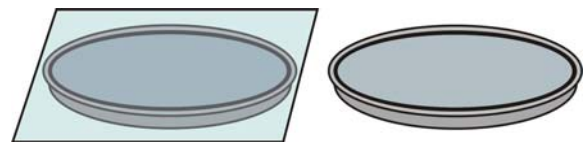
10 Take two round aluminium containers with the same dimensions and put the same amount of water in each one, 100 ml for instance. Then, use a piece of plastic film and/or Plexiglas to cover one of the two containers on top. Take them outside and leave them in the sunshine for half an hour or so (*see drawing aside*).



What do you observe? How does the temperature increase in the covered container and how in the other one? Record and compare your measurements. You may use the indicative table below.

	start	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.
water in the open round container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C
water in the covered round container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C

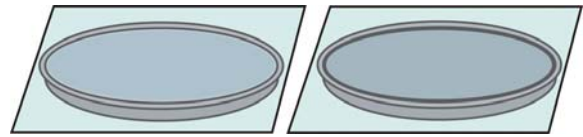
11 Take two round aluminium containers with the same dimensions and paint them both black inside using non-toxic black paint. Leave them to dry for a while and then put 100 ml of water in both. Then, use a piece of plastic film and/or Plexiglas to cover one of the two containers on top. Take them outside and leave them in the sunshine for half an hour or so (*see drawing aside*).



What do you observe? How does the temperature increase in the covered container and how in the other one? Record and compare your measurements. You may use the indicative table below.

	start	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.
water in the open black & round container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C
water in the covered black & round container	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C	__ °C

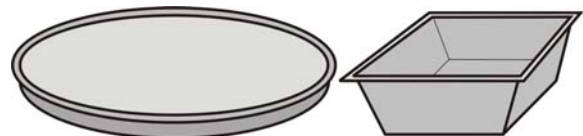
- 12** Take two round aluminium containers with the same dimensions and paint one of them black inside, using non-toxic black paint. Leave it to dry for a while and then put 100 ml of water in both of them. Use two pieces of plastic film and/or Plexiglas to cover both containers on top. Take them outside and leave them in the sunshine for half an hour or so (*see drawing aside*).



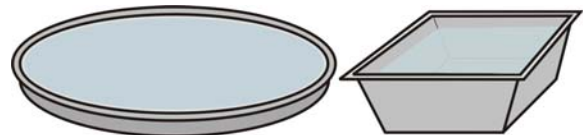
What do you observe? How does the temperature increase in the black and covered container and how in the unpainted and covered one? Record and compare your measurements. You may use the indicative table below.

	start	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.
water in unpainted round & covered container	___ °C	___ °C	___ °C	___ °C	___ °C	___ °C	___ °C
water in the round black painted & covered container	___ °C	___ °C	___ °C	___ °C	___ °C	___ °C	___ °C

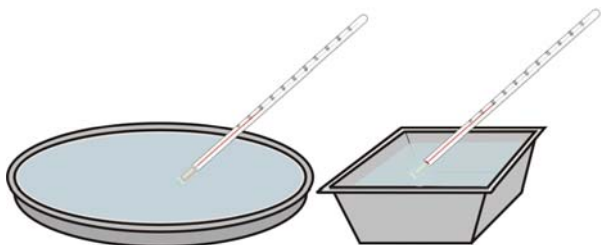
- 13** Take one round aluminium container and a parallelepiped one.



- 14** Put the same amount of water in each one, 200 ml for instance. The round container may look "more full" than the parallelepiped one, especially if it is rather shallow. Take them outside in the sunshine and leave them for 30 minutes or so.



- 15** Take water temperature measurements every 5 minutes using two alcohol thermometers (*see drawing aside*). You may use the indicative table below to record your measurements.



What do you observe? How does the temperature increase in the two containers? Record and compare your measurements.

	start	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.
water in the round container	___ °C	___ °C	___ °C	___ °C	___ °C	___ °C	___ °C
water in the paral/ed container	___ °C	___ °C	___ °C	___ °C	___ °C	___ °C	___ °C

There are many other combinations of containers and covers you may wish to experiment with, but always bear in mind what you keep the same and what you change, in order to conduct a fair experiment.

Some photos from children experimenting with aluminium containers filled with water, out in the school yard ...

Children of the 6th grade have experimented in pairs with various settings of aluminium containers heating up water out in the school yard on a sunny day, recording their measurements in relevant tables and creating charts and posters afterwards.



Photo 1: A class of 6th grade children experimenting out in the school yard with simple solar collectors in aluminium containers, heating up water in the sunshine.



Photo 2: A pair of children experimenting with round aluminium containers, uncovered, with one painted black inside.



Photo 3: Another pair of children experimenting with different settings of aluminium containers. Notice the Styrofoam frames under the aluminium containers, providing insulation with the ground.



Photo 4: Another pair of children experimenting with different settings of aluminium containers. Notice how the alcohol thermometer is being used in the correct angle to measure the water temperature in a shallow aluminium container.

References & Resources

- Eastland, C.** (1999). Teaching about Energy: Practical activities for 7-11 year-olds, The Centre for Alternative Technology (CAT) Publications.
- Narayanaswamy, S.** (2001). *Making the Most of Sunshine: A Handbook of Solar Energy for the Common Man*. New Delhi: Vikas.