THE EXPERIMENTALIST

An Encyclopedia of Science and Technology for young people

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Editorial

The aim of technology should be to serve the people, but low cost appropriate technology is not often accessible to many. Here in Mozambique there are many industries and many technologies, but most of the technologies are not available for the rural poor.

About ninety per cent of homes have no electricity. Most children in rural areas do not have adequate lighting at night to do their homework. Most of the poor have no access to mechanised agriculture. And so on.

In general, industries in Mozambique produce for the richer level of society, not for the poor. One reason is that they assume that this is the way to make more money - sell to few people at high prices. However, there is a different logic, that few consider, but it would be beneficial economically and socially - by selling to a very large market at very low prices.

This implies the need for research to invent low-priced equivalents of the high-priced commodities. Part of the industries of Mozambique and universities should be dedicated to this investigation. Then, the results should be promoted to local industries.

If the product is really cheap in terms of raw materials, tools, skill and work, such "industries" could be industries at village level and can contribute to employment in the country.

In this "Experimentalist" we present an example of the attempt of our Spark Group to do research in this field - the replacement of corrugated iron with sheets made of empty beer cans. **Keith Warren**

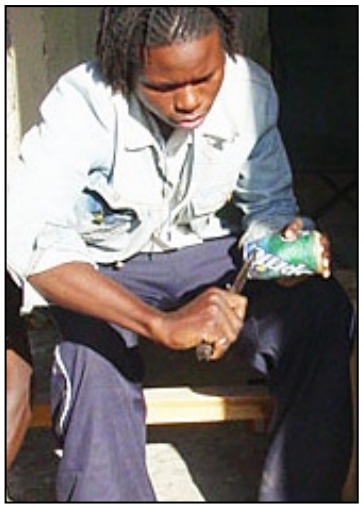
<A small, cheap, commercial wind turbine

How to make Roofing Sheets using Empty Tins

The photo shows Belmiro of the Grupo Faísca with sheets made by him and the Group.

The basic idea is: join halves of empty tin cans to make the equivalent of the roofing sheets commonly called corrugated iron.

A diagram of the idea - the halves riveted together, side by side, to form rows and then joined vertically to create sheets.

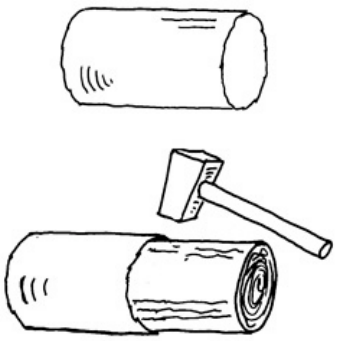


How to cut the cans

Cut off both ends of the cans.

You need a thin knife with a sharp point, for example an "Exacto". An ordinary knife is too thick cut neatly.

The cut edges of the cans will be irregular.



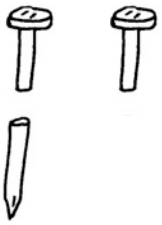
Therefore, you need to beat them lightly with a hammer over a tree branch to straighten them and make them nicely cylindrical.

Then cut them in half with strong scissors.

Now, join these cut cans using rivets.

Rivets

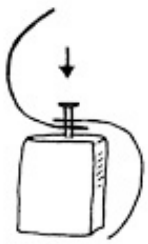
Cut 1 inch nails, (2.5 cm) to a length of 0.5 cm, ready for the next step.



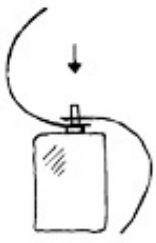
Using a 1 inch nail, make a hole through two half-cans positioned so > and keep them in position.

Insert a rivet into the hole. Hit the rivet (the end that has no head) on top of a heavy block of metal, thus spreading the edge, creating another head on that side. The best hammer is called a ball hammer, with a round head. This spreads the rivets better than a normal hammer.

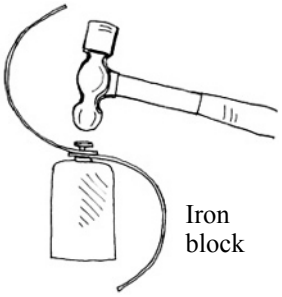
Make two more holes and repeat the process.



Wooden block



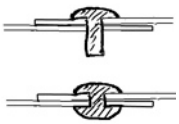
Iron block



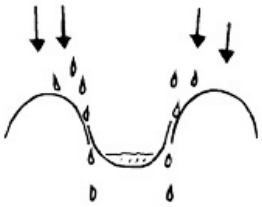
Iron block

Then join more, until you have a row with the required width.

Take care. Arrange the cans in a way that does not allow the rain to go through the roof.



Not so >



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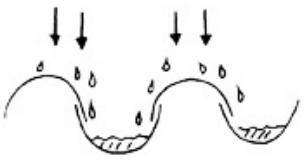
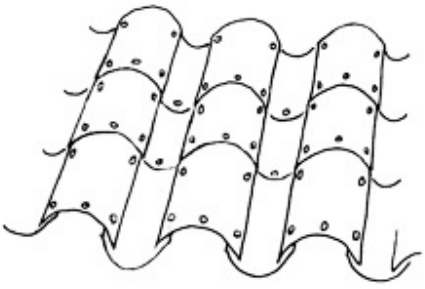
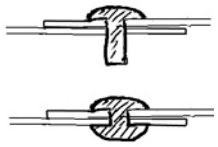


Now, make more rows and then join the rows together (using the same process) until you have a sheet of the size you want.



Aluminum Rivets

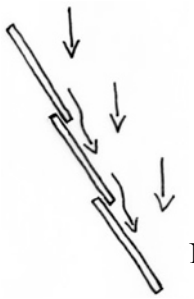
Cheaper (and easier to work) are aluminum rivets instead of nails. Try to get some pieces of aluminum cable. (Ask for left-over pieces from the Electricity Company.
Cut one centimeter lengths. Put one in the hole and hit on one side. Then hit the other side, thus making two heads.



Finally, the sheets should be painted to prevent rust.

The rows should be placed so as not to allow rain to penetrate the roof.

Like so >



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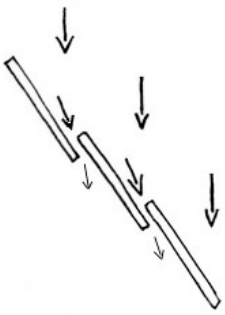


How to Make a Soldering Iron and a stove to heat it

Soldering is a process for joining metal items. You apply heat and a metal alloy (‘solder’) to the joint until the solder melts into the joint, and then let it cool. This results in a metallic bond between the metals. It is strong and has good electrical conductivity.

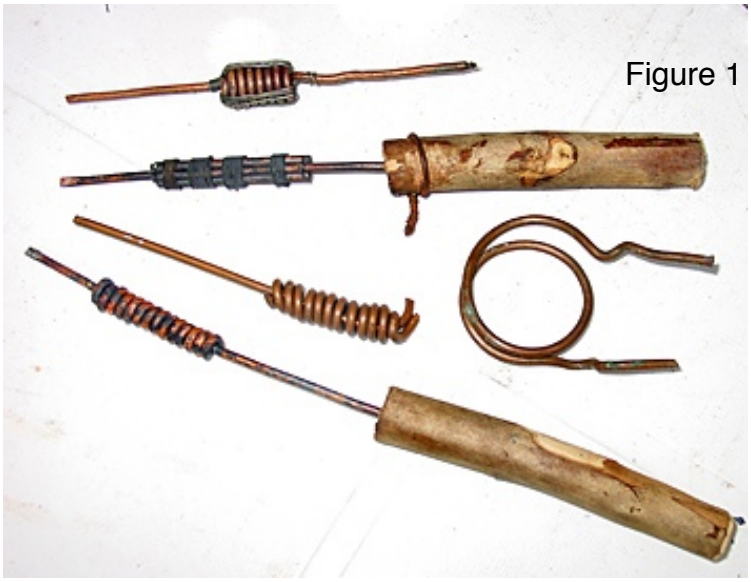


Figure 1

The Soldering Iron

Get some thick copper wire (taken from an electric cable). Wrap the wire around another copper wire to make it massive to maintain the heat.

The pictures show various possibilities.

File a chisel point at the end of the head. >

Then make a handle with a piece of wood.

Now you have a simple soldering iron. Figure 1 above shows various methods of making it.

The wire should be thick (3 mm or more). If you don't have such wire thick, twist two or three wires together. >

The Stove

Make a 'punch' with a piece of iron pipe. File the edge to make it sharp for cutting holes. Get a tin can and hammer the punch until cuts a hole in the can. Cut a similar hole on the other side of the can. (It is necessary to put a large piece of wood inside the can so as not to crush it.)

Insert a piece of iron tube into the holes, as you can see in the photo. Close one end with clay or a piece of tin.

With a big nail, make holes in the bottom of the can for air to enter. And make a stand of iron wire to support the stove above the table so as not to burn it.

The photo shows the soldering iron inside the heating tube.

Make a charcoal fire in the can.

F - Inside here is burning charcoal.

T - Closed end.

The result is a 'stove' in which to put your soldering iron. A a domestic stove is too hot.)

So now you have a soldering iron and a stove to heat it. A soldering iron so small is not capable of soldering big things. But it serves well for soldering electronic components in an amplifier or a radio.

Make some sort of a stand so that air can enter underneath.

Commercial soldering irons

A commercial electric soldering iron and a commercial soldering iron to heat in a fire.

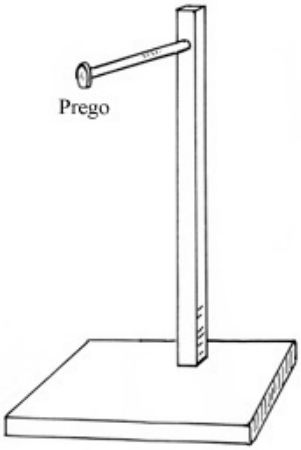
In Mozambique there is no lack of ingenious young people.

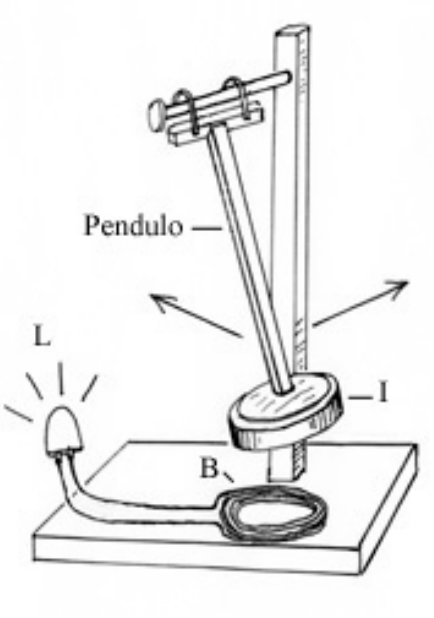
A wheel for sharpening knives in Lichinga Market.

Wind Turbine Generator Models

A magnetic field moving relative to a conductor, generates a voltage. In simple terms: a magnet moving across a coil makes electricity.

Demonstration: A pendulum with a magnet on the end oscillates from side to side over a coil. It produces a voltage that can power a light.



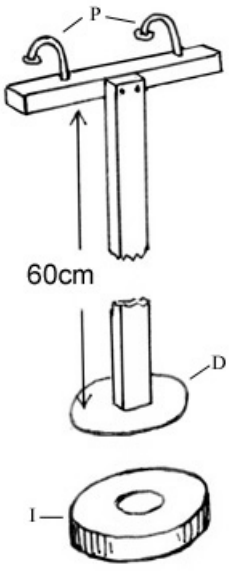


Outline of the idea

I - Magnet. It must move very near to the coil

B - Coil
"**Prego**" = Nail
L - LED Lamp

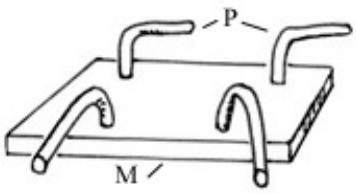
This device is not useful in itself, but is a simple demonstration of how an electric generator works.



P - Curved nails to hang on horizontal nail

D - Iron disk fixed with a screw below. (For example the lid of a can)

I - Magnet (magnetism holds it to the lid).



Device for winding the coil. After winding, turn the nails to remove the coil.

P - Curved Nails
M - Wood

Complete coil. Fifty or a hundred turns of enameled wire. >>

We can use this idea to create a generator for a wind turbine.

<The photo shows the idea: a device with 4 magnets, fastened to a tin, passing 4 coils.

The tin may be replaced by a wooden wheel with magnets attached.

The poles of the magnets alternate: N - S - N - S - N and so on.

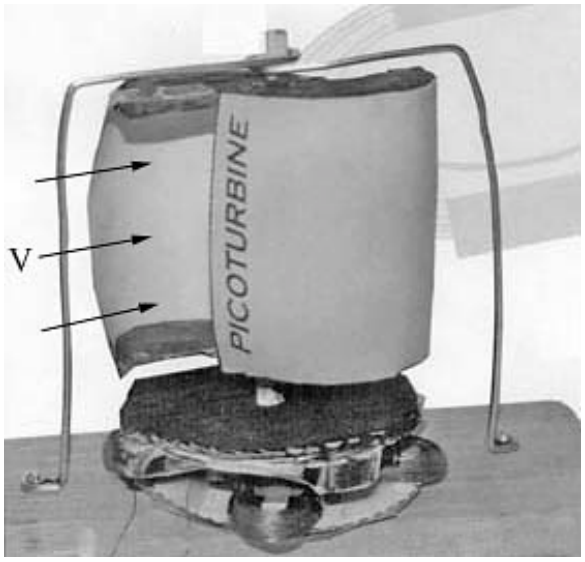
The coils can be connected or in series or in parallel.

The voltage depends on the number of turns in the coil and the rotation speed of the magnets.

A small model of a wind turbine that has a generator of this kind. >
It has a height of approximately 10 cm.

Some commercial wind turbines use this method, called a "vertical axis wind turbine" (VAWT).
The advantage is that they produce a high voltage with a low rotation speed, because the magnets pass the coils quickly.

Most commercial wind turbines have horizontal axes and a high speed generator, which is much more expensive. >



V = Wind

A real (small) commercial turbine

The two photos show a generator with 16 pairs of magnets and coils.
Manufacturer: Boondee. (Vertical Axis Wind Turbine, ModelBWV-8808, "Savonius' wind turbine)
See: (http://www.boondee.net/windturbine/)
Output power: Alternating Current. Single phase.
Wind Speed: 04.05 km / hour 7.6 V, 300-500 mA
Wind Speed: 05.07 km / hour, 7-12 V, 500-1000 mA
Wind Speed: 7.10 km / hour, 12-20 V, 1000-2000 mA
Wind Speed: 10-30 km / hour, v 20-50, 2000-5000 mA
16 coils
Blade width: 27 cm Up - Medium 44 cm - Base 27 cm,
Overall diameter of the turbine: 79 cm

Average wind speeds in the Airports of Mozambique

(Kilometres per hour - km/ h)
Beira 17 km/h
Chimoio 7 km/h
Inhambane 6 km/h
Lichinga 28 km/h
Nampula 6 km/h
Pemba 13 km/h
Quelimane 17 km/h
Maputo 17 km/h

A pulley with a rope.

The large stone descends because it is heavier. >>

The same idea with a chain.

A chain can also flow (run) from a high jar to a lower jar.

You can use a thin chain or a metal necklace purchased at a hardware store.

In this case, the edge of the jar is a 'pulley'.

The outer part weighs more than the part hanging inside the jar and the chain flows until ... it all descends to the table.

A water siphon

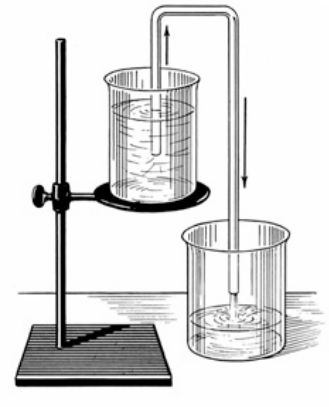
We can do the same thing with water.

Pour water into a jar.

Put coloring in the water (food colouring will do). This is to make the water more visible.

You need a transparent plastic tube.

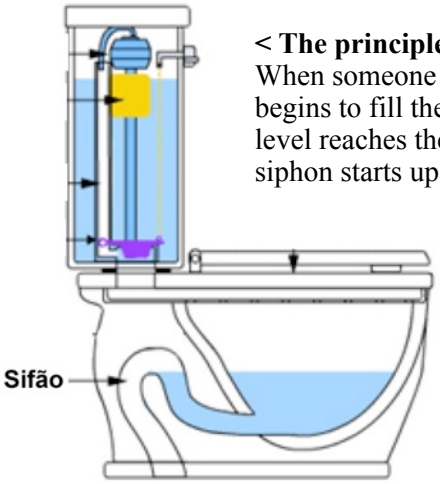
Suck to fill the tube with water, then put the lower end in the jar. The water runs down to the jar because the water outside the tube is heavier than the tube inside (because it is longer).



People use the same process to remove petrol from the tank of a car.

This device is called a **siphon**. A siphon is a device for transporting a liquid from one height to another lower down, passing through a higher point.

< A laboratory siphon.

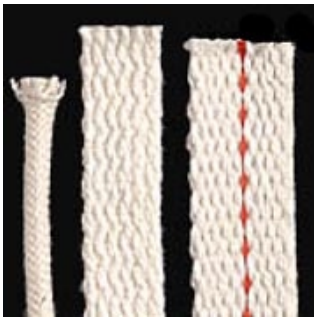


< The principle of a siphon in a toilet. When someone pulls the lever, the water begins to fill the bowl. When the water level reaches the level of the curve, the siphon starts up and empties the bowl.

The siphon is used in agriculture. In the photo, the water level in the canal is higher than that in the garden so the water flows to irrigate the garden. >

A siphon made of a 'lamp wick'

Liquids rise by the ‘capillary’ process in wicks: liquids move along thin tubes or in small gaps between fibres. We made a 'wick' with several lengths of thick cotton string bound with sewing thread.



When we put the wick in the coloured water, the water begins to rise.
The water moves first by ‘capillarity’.
When the water in the wick outside the jar reaches a level below the water level in the jar, it is heavier and continues to descend, just as water did in the tube.
It is a siphon.

When it reaches the end of the wick it begins to drip down into the lower jar.

A filter for dirty water

We can use the process to clean up cloudy water.

The water comes out clear, leaving the dirt in the filter.
The siphon acts as a filter.

The water comes out apparently clean. But beware! The siphon just takes out the dirt particles, not dissolved substances. It does not filter microbes or diseases. It does not filter invisible pollution.

A bigger siphon

To provide a greater amount of water for domestic use, the wick should be thicker and longer.
For the wick, use a towel. Roll it and tie with string.

Then, use it like the siphon filter described above.
The bucket of dirty water should be in a high position.

The water that comes out is clear, but not drinkable. With this towel, the siphon produced approximately one litre of clear water in two hours.

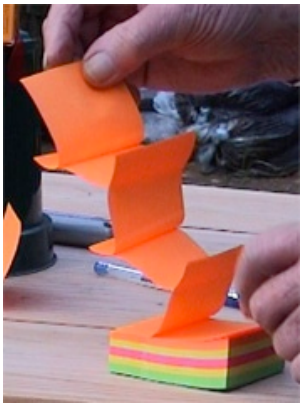
Something different but still a kind of siphon

The 'Post-it' is a small paper (7.5 cm in size) with an adhesive for easy removal on the back, so that it can be easily stuck, removed and replaced a few times, without leaving marks or residue. They are sold in packs of about a 100. They are used to make notes and are usually placed on computer monitors, work places, notebooks, etc. They are used to leave reminders on a door, such as: “Back at four o’clock”.

Buy a packet of Post-it.

Take off a sheet

Turn it and stick it the other way round on the next paper...



... until you have a chain of papers.

Place a pile of these joined papers in a high position.

Lift up the first few and let them fall to the side. The papers run one after another in a fascinating way.

The photo is of a man playing in his office.

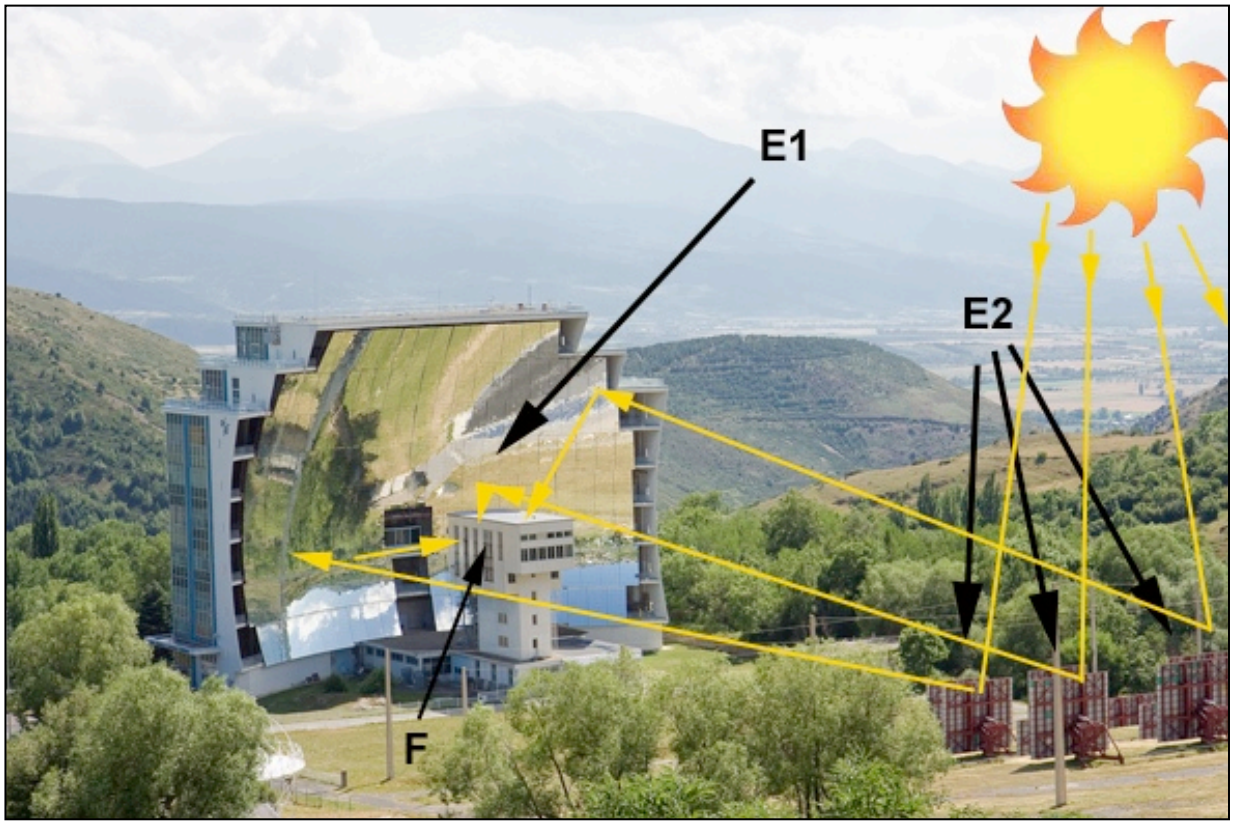
There is a good film on YouTube. URL:

http://www.youtube.com/watch?v=Y1rZqw5bXb4

Try it. It’s very amusing.

And it works like siphon.

The Biggest Solar Furnace in the World



A solar furnace is a mirror that focuses sunlight on a small area to heat something.

The solar oven in Odeillo, France, is the largest in the world. The site was chosen because the air is very clear and the region has about 300 sunny days per year. It was built in 1969.

Sixty-three **E2** heliostats direct the sunlight into a huge parabolic mirror (**E1**) of nearly 2,000 square meters. (A heliostat is a small mirror that moves as the sun moves, to direct the sun's rays on to the parabolic mirror. The heliostats are controlled by a computer.)
It is a scientific instrument. It explores the actual and potential uses of solar energy.

The parabolic mirror directs the rays to a small area called the "focus" of about 80 cm in diameter, located in building (**F**) on the photo. The sun's rays consist of light and heat, so the power of 2,000 square meters of solar energy reaches the focus of 80 cm diameter, which becomes extremely hot, producing temperatures exceeding 3,200 degrees Celsius. (Steel melts at approximately 1370 degrees C.) Its power is one million watts.

One of its great advantages is that it provides a clean heat. The object to be heated is not in contact with fuel electrodes. In fact it can be heated in a vacuum.

A domestic version

This type of device (very much smaller) is used for cooking. It's called a solar cooker.

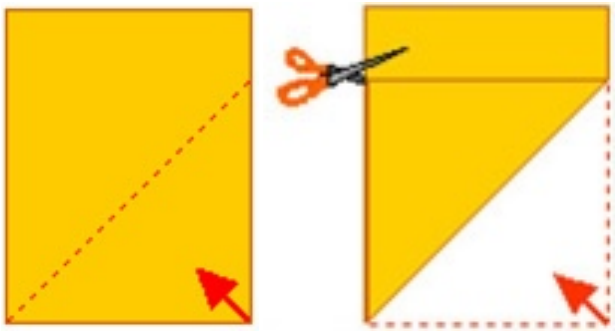
The photo shows a woman cooking a meal.
The focus and the pot are so intensely bright that they can hardly be seen in the photo.

A solar cooker under construction by the Spark Group, Catembe, in 2006.

A larger cooker capable of cooking 400 loaves per day. It is mounted on a trailer and can be pulled by a car.

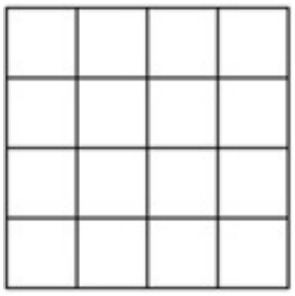
Make a tangram

A tangram is an ancient Chinese puzzle, sometimes called "seven pieces of cleverness." The object of the puzzle is to rearrange the pieces of a square (the puzzle pieces) to form figures (like a picture of a cat) using the tangram pieces. Start by making a square piece of thick coloured paper or card. To start making the square: if your paper is rectangular,, fold one corner over to the adjacent side.



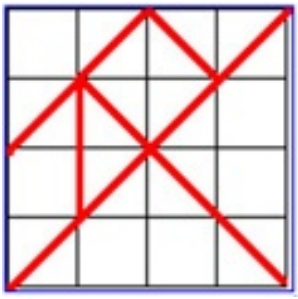
Cut off the small rectangle, leaving a square. You do not need the small rectangle.

Fold the square piece of paper in half, then in half again (making a square that is divided into quarters).



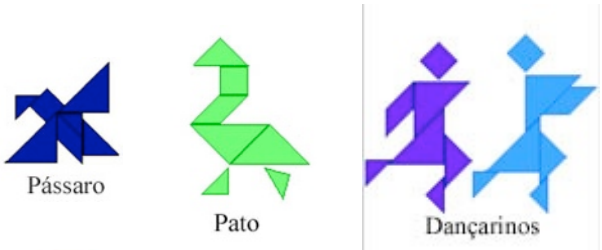
Repeat this step. Now you have a square divided into sixteenths.

Unfold the paper.



Draw lines along the red lines marked at the right. Cut along these lines.

You now have seven pieces: a small square, two small isosceles triangles, a medium-sized isosceles triangle, two large isosceles triangles, and a parallelogram.



Arrange these seven pieces into shapes, making animals, people, everyday objects, etc.

You must always use all 7 pieces. That is the rule. See how many you can make. Invent new ones!