

Warning and precautions

This kit is not a toy. It has been designed for teaching ends, for training and experimentation of photovoltaic solar energy, in educational environments under the surveillance of an adult.

It is necessary to take necessary precautions to handle tools and to avoid damaging them.

This kit functions only with solar energy and requires no other electricity source (battery, electrical network)

Do not connect any cable to an electric current plug, under serious electrocution danger.

Do not connect any cable to a battery, this could cause a short-circuit, a very high temperature and probably burns and/or fires.

It is necessary to take necessary precautions when the motor turns, propellers can cause wounds and cuts if they touch certain part of the body.

Do not leave this kit close to children nor mascots. They could be choked with the included small parts

The motor of the kit has been designed to operate once photovoltaic cells connected to the kit. It should not be connected to another source of electric current (battery, transformer, etc).

Cebekit could not be considered responsible for the consequences due to a use different from the indicated in this manual.

When this product will not be used any more, it will not have to be thrown with the domestic waste. It must be given to a point of selective recovery for electrical and electronic appliances for its recycling.



Short introduction to solar energy

Bases

Photovoltaic solar energy systems take profit from the energy which we receive from the sun and transform it into electricity.

Its name comes from the Greek word "phos" (light) and "Volt", in tribute to Italian physique Alejandro Volta (1820-1891), pioneer in the study of the electric phenomenon. It literally means "electric light", although it is usually used to refer to the "solar cells". The discovery of the photoelectric effect goes back to 1839. In 1870 he was studied by Hertz. In 1876 it was already obtained solar cells with outputs from 1 to 2%.

The first commercial silicon cell was obtained in 1954, but its output of 4% limited its use to applications like the artificial satellites.

Nowadays Cebekit and Fadisol offer high quality cells and solar modules, with a useful long life, a high efficiency and an economic price for educational (Cebekit) and professionals (Fadisol) applications.

The photovoltaic effect

Currently the most usual solar cells are those made of silicon.

To manufacture them it starts from a cylindrical silicon crystal obtained by fusion. This crystal is doped with a small amount of impurities which transforms it into an electricity driver. If it is doped with phosphorus it is obtained a "N" crystal (electrons conductor). If it is doped with boron, it is obtained a "p" crystal (positive "cavities" or loads conductor). The crystal is cut in very fine seals (fractions of millimeter).

To manufacture a solar cell with "union p-n", it is used a "N" seal and on its surface it is melted boron at high temperature, to obtain a fine layer "p". This one is the face which will be exposed to the solar radiation.

When a "photon" (light elementary particle) of the solar radiation will hurt to "the union p-n", it will be produced a pair "electron-hole". The electron will tend to move towards the silicon "p" area. If we connect conductor wires in the "p" and "N" areas, the produced electric current will circulate through the electric application which is connected outside (motor, bulb, LED, etc...).

The photovoltaic system is characterized to have no mechanic piece in movement, neither fluids circulation, nor no fuel consumption, being thus a clean energy and completely sustainable. The silicon necessary for the photovoltaic cells manufacturing is, after oxygen, the most abundant material on the Earth.

Short introduction to solar energy. ←

Solar energy

Solar energy is continuously emitted by the sun in the form of radiant energy. The solar radiation level received in the atmosphere is 1353 W per square meter. While crossing the atmosphere, and because of the absorption of air layers composing it, the maximum solar radiation that we can measure on the Earth at sea level, with a complete clear sky and when the sun is in its highest point, is 1000 W/m². The more we approach the equator of the Earth, the more the solar radiation is, because solar rays arrive more perpendicularly and must cross less air layers.

Cells, modules and photovoltaic fields

The photovoltaic cell is the basic element of a solar installation. The voltage produced by a single one cell is only suitable for small basic applications. If we interconnect several equal cells in the same structure we will obtain a photovoltaic solar module. Most modules are composed by 36 cells. Moreover modules can be connected between them to form a photovoltaic field and to obtain the required power. It 'is what we can see on houses or villas roofs, factories or large buildings roofs, as well as large installations of "solar garden", which actually are large power plants to produce energy called "green", because its production is based on the solar energy which does not contaminate, and it is inexhaustible. The solar cells are generally sealed with transparent resin, to protect them from moisture and pollution. Solar modules are generally assembled into an aluminium framework and they are frontally protected with an anti-reflecting claimed crystal.

Installation and Maintenance

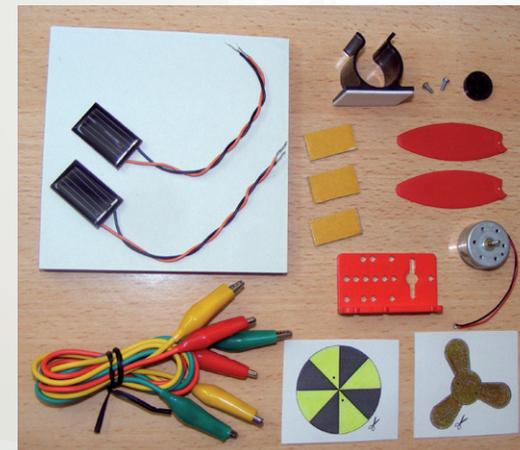
It is essential to adequately select where each solar module will be installed. The system's output will depend on that. The panel must be in front of the sun as much time as possible. The best situation is at midday in front of the south (in the northern hemisphere). Another important consideration to take in account is that cells can't be touched by projection of buildings, trees or other elements shadows. The single necessary maintenance is to remove possible sheets or dirtiness deposited on the frontal part, because they can reduce the surface of energy catching. Small cells will be cleaned with a soft and dry rag.

Module assembly for solar experimentations ←

Before to assemble this kit, it is necessary to read and understand these instructions and to be familiarized with pieces of this kit.

Kit contain ←

piece n°	article	quantity
1	1,2V -75 mA photovoltaic cell	2
2	Basis made of fine cardboard 10x10x1 cm	1
3	cable with 2 clips crocodile	3
4	Motor support, with adhesive basis	1
5	M2 x 5 mm screws	2
6	Rotor axle box	1
7	Propeller	2
8	Adhesive 2 faces cushion	3
9	Square for motor assembly	1
10	Solar motor with high sensitivity	1
11	Cardboard with pictures to cut	2



Assembly ←

Introduce the motor on its support by pressure, taking care that cables remain on the open part of the pincer (fig. 2 and 3).

The motor must be close-cropped to the support on the side of the axis output (fig. 3).

Now fix this unit at the assembly square, for that it is necessary to stick a cushion centered on the square narrow basis. Remove the protective adhesive label of the motor support (fig. 4).

Put the square on a flat surface on its narrow basis, do the same thing with the motor and connect them (fig. 5).

Remove the protective label from the cushion of the square lower part and fix the motor set to the center of one of the basis side parts (fig. 6).

Motor Set (1)

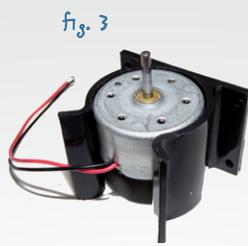
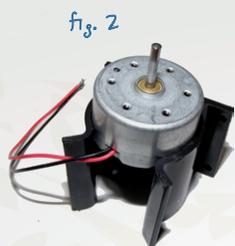
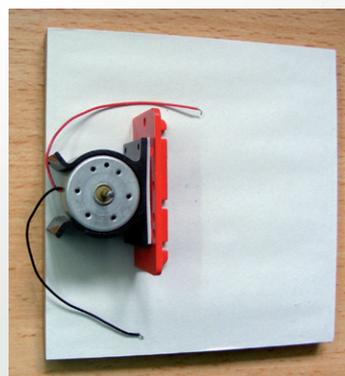


fig. 5



fig. 6

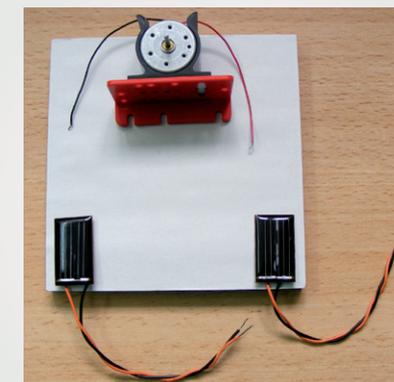


Photovoltaic cells ←

Stick an adhesive cushion on the posterior part of each two photovoltaic cells. Remove the protective labels and fix cells in corners opposed to the motor (fig. 7). Cells are assembled far away from the motor, to avoid propellers to project their shadows on cells.

Photovoltaic cells (2)

fig. 7



Propeller ←

Locate the parts number 5, 6 and 7 (fig. 8). Place the propeller on the axle box in the position indicated on the picture and fix it with a M2 screw (fig. 9). Then fix the other propeller (fig. 10). Once assembled propellers they must be perfectly aligned (fig. 11).

Propeller (3)

fig. 8



fig. 9



fig. 11



fig. 10



Printed fine cardboard figures

Attention, children must carry out the following operations under surveillance of an adult and to use suitable scissors for children.

To choose the figure which you wish to install on the axle box rotor. Carefully cut out the fine cardboard (fig. 12). Place the cut out figure on a cushion to punch, a felt or a folded rag, and with a punch, a toothpicks or similar, carefully "prick" two points marked on the drawing, to open two holes to pass the fastening screws (fig. 13 and 14). Place the axle box with the flat face to the top (fig 15). Put the cut out figure on the axle box and fix it through the two holes using the two M2 screws (fig. 16). This system allows changing figures or propellers, according to your needs. You can carry out your own designs on a fine cardboard and then to color them, to cut out and fix them at the axle box rotor with the two M2 screws supplied with the kit. To assemble the rotor axle box on the motor you will have to insert it into pressure on the axis of the motor (fig. 17.18 and 19).

Printed fine cardboard figures (4)

fig. 12



fig. 13

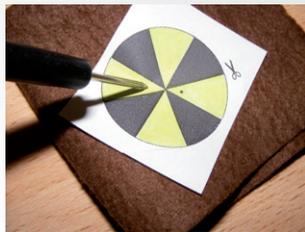


fig. 14

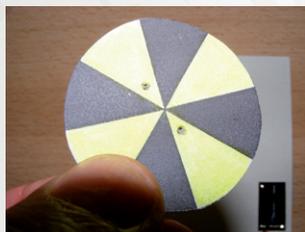


fig. 15



Printed fine cardboard figures (4)

fig. 16



fig. 17

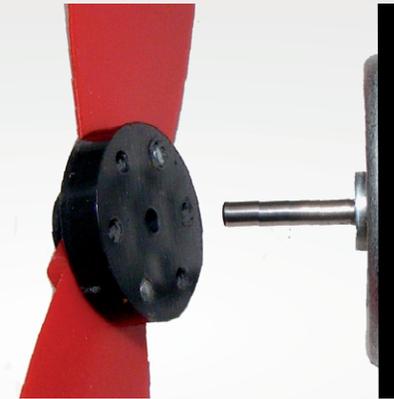


fig. 18

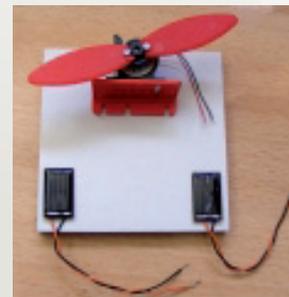
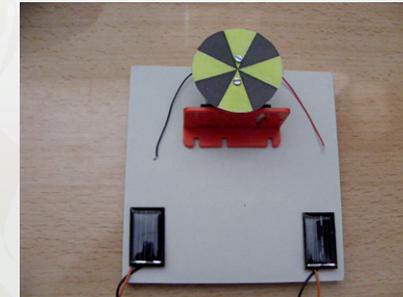


fig. 19

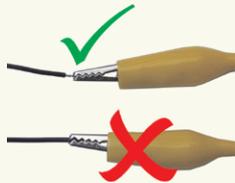


Your own photovoltaic laboratory is ready. When the sun is shining you will be able to carry out your tests with solar energy.

Previous considerations

Experiments indicated hereafter are to show how photovoltaic cells produce electricity by receiving solar light. You will learn in an amusing way different modes to connect them.

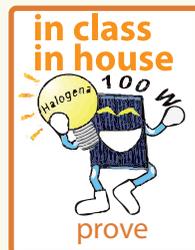
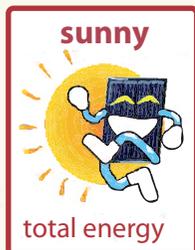
To do connections and to be able to easily and quickly carry out changes you will have to use flexible cables equipped with the clips crocodile included in the kit. Pay attention that pincer is in correct contact with the cable conductor and it does not grip the insulating plastic cover. (See figure)



Experiments will correctly operate, only if the cells are under the direct sun light.

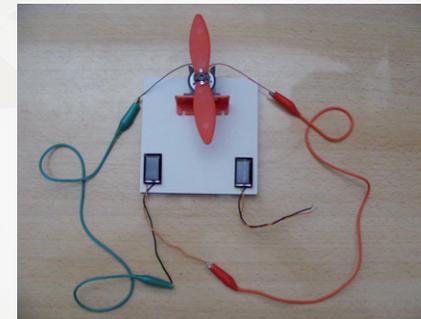
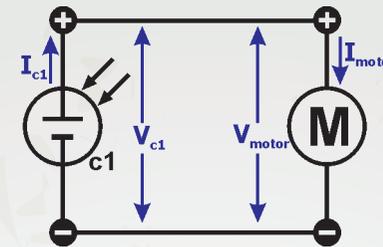
Even with sunny or half-sunny days, results of experiments can considerably vary according to the solar radiation level at each time. Cloudy days you will be able to carry out experiments in class or in your home if you illuminate cells with a lamp equipped with a 100W, or 50W halogen lamp

According to the experiment, you will only have to put on the motor the axle box rotor, the propeller with 1 or 2 parts or different fine cardboards with printed drawings of the kit or to put your own designs.



Experiment N°1: Motor connected to 1 solar cell

To be able to correctly see if the motor turns it will be necessary to insert the axle box rotor into the motor axis. Use cables with clips crocodile to carry out connections. Connect the red cable (positive pole) of one of the two cells, with the motor red cable and the black cable (negative pole) of the same cell, with the motor black cable. Place your solar laboratory directly at the sun.



What does it happen?

If the cell receives enough solar radiation, the motor will turn.

Why?

Solar cell produces electric current when it receives enough solar radiation. Voltage produced by the cell is between 0.5 & 1 V (according to the received light level). The kit's sensitive motor starts from 0,5V approx., if the cell can provide approx. 25 mA D.C.. If the motor had a propeller or another devise it would be necessary more energy to start.

Experiments suggestion to carry out in the same installation:

Experiment n°2

Put your solar laboratory under the direct sunlight and observe how the motor turns. With the hand opened at 50cm from the connected cell, try that the shadow of your hand is projected on the cell, to cover direct solar light.

What does it happen?

Why?

Because it doesn't receive enough solar energy, the cell cannot produce necessary electricity to activate the motor.

Repeat the same previous action but with fingers very separate. Place your hand at the suitable distance to allow your fingers' shadow covering the cell light. Now slowly move your hand under the sun, the allow cell to alternatively receive sunlight and shadow. See well, think about it and what conclusions can be drawn ?

Experiment n°3

Follow indications of the propeller assembly (see paragraph Assembly, point 3). Once assembled, insert it in the motor.

What does it happen?

If the cell receives enough solar radiation, the motor will turn. Of course the motor speed will be less or it will be more difficult to start.

Why?

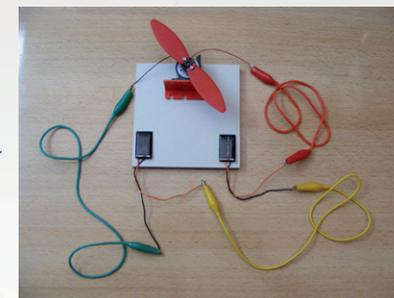
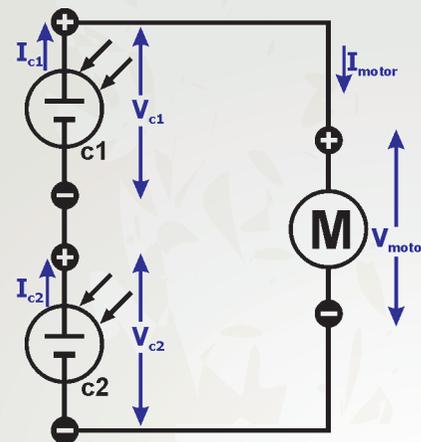
The propeller is a load for the motor, its weight and friction with the air while turning requires to the motor more energy than the experiment n°1. According to the present solar radiation level, the cell will not be able to produce enough energy to activate the motor.

Experiment n°4

Remove one propeller. See what happens and try to find why.

Experiment n°5. Motor connected to 2 solar cells in series

Use a cable with clips crocodile to connect the red cable (positive pole) of one of the two cells, with the motor red cable. With the other cable with grips connect the black cable (negative pole) of the same cell to the red cable of the second cell. The black cable of the second cell must be connected with the third cable with grips to the motor black cable. Install the propeller on the motor. Put cells under the direct sunlight.



What does it happen?

If cells receive enough solar radiation, the motor will turn but faster than in the previous case.

Why?

Connecting two cells "in series", voltage received by the motor is the sum of the voltage of each cell. As the two cells are equal, the voltage of the motor in this assembly is the double of the voltage received in the experiment N°3

$$V_{motor} = V_{c1} + V_{c2}$$

Moreover, in a "series" connection, the intensity circulating through the motor will be the same than the intensity circulating in each cell.

$$I_{motor} = I_{c1} = I_{c2}$$

With a good solar radiation and if the motor requires it, these cells can provide up to 70 mA approx.

↪ Experiments suggestion to carry out in the same installation:

Experiment n°6

Remove one propeller and compare results with the experiment n° 4.

Remove propellers and compare it only with the rotor axle box. Does it turn more quickly? Why?

Replace the propeller by fine cardboards with drawings and see the different results. Then compare them.

When you assemble fine cardboard with the cut out three propellers drawing, test firstly with flat propellers, then with propellers inclined towards the left and after to the right.

See well, think about it and what conclusions can be drawn

Experiment n°7

Start from the installation of the experiment N°5.

Once tested and well observed, remove the photovoltaic laboratory from the sunlight and cells do not produce any more electricity (or cover cells with an opaque paperboard or a thick blade).

Now disconnect clips crocodile connected to the two motor cables and connect them as follows: The red cable (positive pole) which is free from first cell must now be connected to the motor black cable and the black cable of the second cell (negative pole) must be connected to the motor red cable. Put again cells under the direct sunlight.

What does it happen?

Carefully observe if something has changed.

Why?

The motor will turn clockwise when the red cable (motor positive pole) is connected to the feeding system positive pole, in our case the cell. The motor will turn anti-clockwise reversing the polarity (changing motor cables).

Experiment n°8.

Start from the installation of the experiment N°5, i.e. the motor is connected with the correct polarity.

Put the assembly under the direct sunlight to allow the motor rotating.

How operate propellers, like a ventilator or an extractor?

You could check it spraying small and very fine papers on turning propellers.

What does it happen?

See well, think about it and what conclusions can be drawn

Experiment n°9. Motor connected to 2 solar cells in parallel

Connect two cells red cables (positive poles) with one of the clips crocodile from one of the cables. The clip crocodile of the other end of this cable must be connected to the motor red cable.

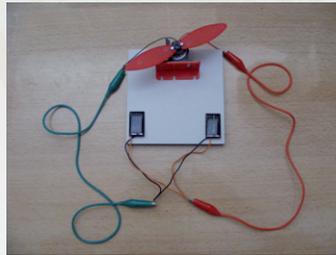
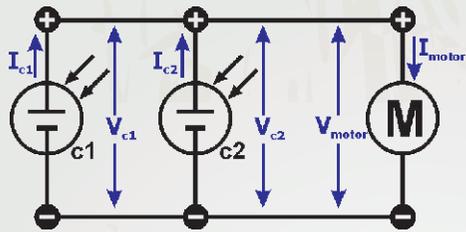
Now with another cable with clips crocodile, do the same thing with the cells negative poles and the motor black cable.

You have just carried out a connection in "parallel", in this kind of connection all identical poles are coupled (positive with positive and negative with negative).

Install the propeller on the motor.

Put cells under the direct sunlight.



Experiment n^o9. Motor connected to 2 solar cells in parallel (**What does it happen?**

Does the motor turn more quickly than with only one cell (experiment N^o1)? Does it turn more quickly than with two cells connected in series?

Remove a propeller of the motor. Does it operate better or worse than experiment N^o4? And regarding the experiment N^o6?

Replace the propeller by several fine cardboards and compare results with those of same experiments carried out with cells connected in series.

Why?

"Parallel" connection can only be carried out with cells which have the same voltage. Connecting them "in parallel" all voltages are equalized and the motor receives this same cells' output voltage, consequently the motor receives the same voltage as in the first experiment carried out with only one cell.

$$V_{\text{motor}} = V_{c1} = V_{c2}$$

Then, what is the advantage of a parallel connection?

Intensities of the currents produced in each cell "are coupled" arriving to the motor cable, i.e. the motor will receive the intensities sum of first and second cell.

$$I_{\text{motor}} = I_{c1} + I_{c2}$$

In our case you will not note a great difference because the motor is a high efficiency motor and it requires a small voltage to operate. In other words, the motor speed depends on the voltage. The intensity of the current depends on the motor's requirement even when it will be necessary a higher effort.

Summary

When you wish to use electronic devices requiring more voltage than the produced by a single cell, it will be possible to group "in series" as many cells (equal) as it is necessary to reach the needed voltage. The maximum current intensity absorbed by the device will be equal to the maximum intensity produced by one cell.

When you wish to use electronic devices requiring a higher current than the produced by a single cell, it will be possible to group "in parallel" as many cells (equal) as it is necessary to reach the needed current. The output voltage will be the same for all that means the voltage of a cell.

It is also possible to do a mixed connection (combined series and parallel) of equal cells, to reach the wished current and voltage.

You can acquire 4 cells sets like those of this kit, with C-0137 reference. We also have models with higher power.

... more information. ←

Wind energy, cell or fuel hydrogen battery, thermodynamic energy as well as photovoltaic technology, and others like electronics, electricity or mechanics, are some lines with multitudes of kits and products which start from initiation and training in schools till its use and installation in professional areas.

On www.fadisel.com you will find solar energy applications and any type of solutions regarding renewable energies

On www.cebekit.com you will find a wide and complete relation of educational kits and funny training based on renewable energies.

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