Portable laboratory for PV classroom

C-1102

CONTENT MALETIN :

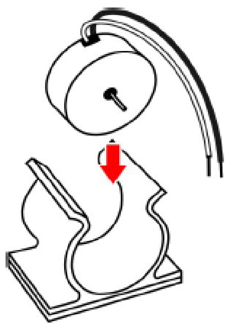
Motor	3 units
Photovoltaic solar cells	12 units
4 blade propellers Ø52 mm	3 units
Motor support	3 units
Bushings	3 units
Screws M2 x 5 mm	9 units
Inclined feet	18 units
Double-sided adhesive foams	20 units
Cables with alligator clips (Assorted Colors)	30 units
Printed patterned cardstock to cut	6 units
LED 5mm red light	3 units
LED 5mm green light	3 units
LED 5mm green light	3 units
Resistors 0.5 W; assortment of different values	61 units
Electronic module test with sound and lights	1 unit
Case classifier for small and medium components	1 unit
Multimeter with test leads and protective rubber	2 units
Digital Light Meter with Protective Case	1 unit
6F22 9V battery (included in the measuring instruments)	3 units
Manually CD	1 unit
Briefcase	1 unit

Installation instructions

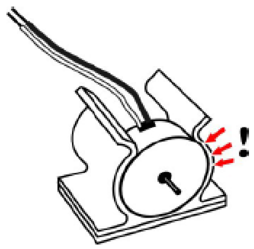
- Follow the instructions step by step.
- Handle components with care to avoid damaging any parts.
- You need to use the appropriate protections and take necessary safety precautions to avoid injury from tools, sharp edges or pointed ends of the components.

Motor assembly in the holder

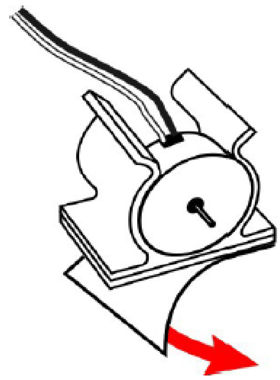
1) Insert pressure in the engine support.
The output cables per share top



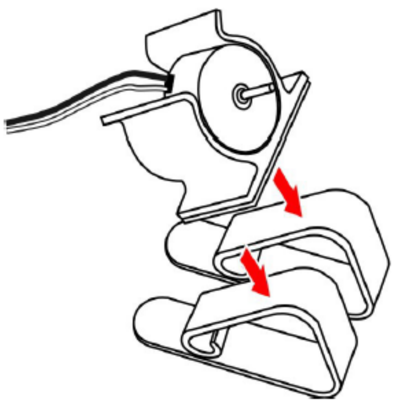
2) The front of the engine has to be flush with the bracket.



3) Remove the protector adhesive pad

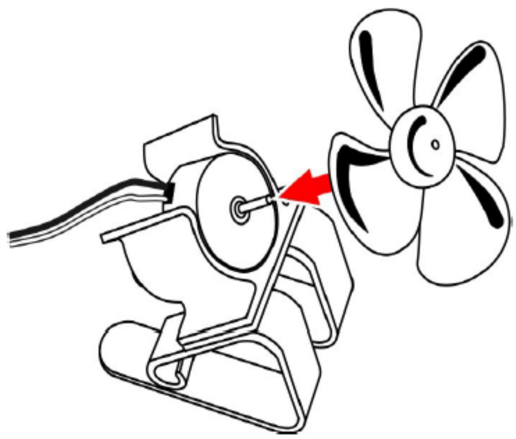


4) Secure motor with its support at the top of inclined feet



Propeller assembly to the motor unit

1) Press in the propeller shaft of the engine. Verify that you can spin freely without touching the inclined support or feet.



Photovoltaic solar cell

Brief introduction to solar energy

The photovoltaic solar energy, use the energy we receive from the sun turning it into electricity.

Its name derives from the Greek word phos (light) and Volt, in tribute to the Italian physicist Alessandro Volta pioneer in the study of electrical phenomenon . Literally mean light - electric , but is commonly used to refer to the solar cells.

The discovery of the photoelectric effect goes back to 1839 by the French physicist Becquerel . The first cell with an efficiency lower than 1%, manufactured by Fritts 1883 .

Research in the nineteenth century of Faraday , Maxwell , Tesla and Hertz and above those of Einstein in 1905 laid the theoretical basis of the photoelectric effect , which is the basis for the conversion of solar energy into electricity.

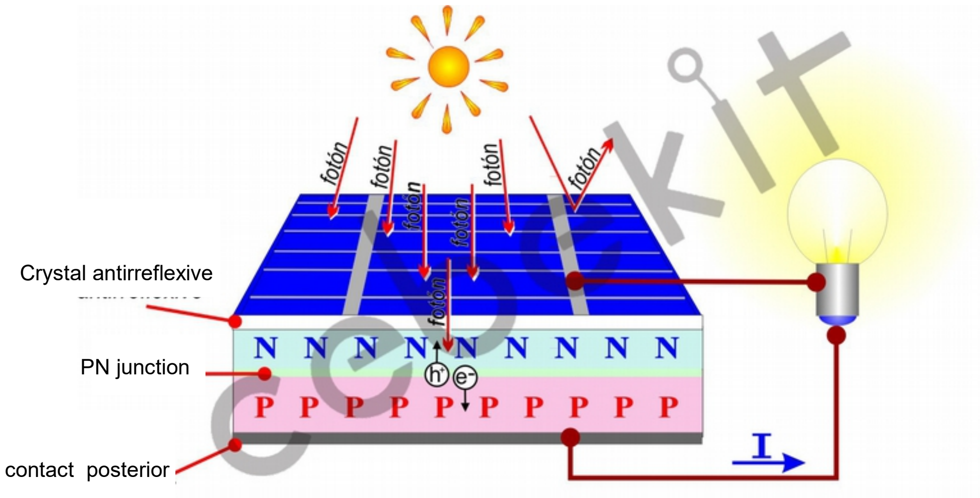
The first commercial silicon cell is obtained in 1954 , but its high cost and low yield (about 4%) limited their use to certain applications like artificial satellites.

Currently we can offer solar cells and modules with high quality , long life , efficiencies above 10% , which in many cases exceed 16% and low prices , ideal for educational, industrial and commercial applications.

The photovoltaic effect:

Top Solar cells are crystalline silicon. This is part of a cylindrical silicon crystal obtained by fusion. Said glass is doped with a small amount of impurity that makes it conductive. If phosphorus is used, we get a crystal n, electron conductor. If boron is doped with a p crystal conductor voids or positive charges is obtained. The columnar crystal is cut into thin wafers (wafers), of fractions of a millimeter (0.300 ~ 0.150 mm).

To obttain e union “pm” wefer “n” is used and the wafer surface boro melts a very hight temperature, thereby forming thin film type “p”



When a photon with sufficient energy, due to radiation, solar collides with the pn junction, an electron-hole pair is produced. The electron will tend to migrate to the region of silicon p. If we connect a few wires to the regions p and n, the electric current produced will flow in the external circuit application, called load (eg a lamp or other electrical or electronic device). Each silicon cell crystaline radiated by sunlight produces a voltage of 0.4 ~ 0.5 V.

The basic difference between a thermodynamic conversion system and a photovoltaic system is that there are no moving parts, and there is no fluid flow, nor any material consumption being a perfectly clean and fully sustainable energy as the silicon required to manufacture cells is, after oxygen, the most abundant material on Earth (27%).

Solar radiation

Solar radiation is the electromagnetic energy emitted by the fusion process of hydrogen in the sun. This solar energy is continuously emitted by the sun king in the form of radiant energy.

The intensity of solar energy reaching the earth depends on latitude, ground level , the season , time of day and local weather conditions .

Traversing the atmosphere and due to the absorption of the air layers , the average value of the solar constant (extraterrestrial radiation) of 1366 W/m2 (*) which we find to the atmosphere , is reduced to the level of 1000 W/m2 sea. For this reason it is preferable to collect solar radiation at a peak. Note , too, that as the sun moves away from the zenith atmospheric absorption increases , increasing the thickness of the atmosphere traversed by the rays .

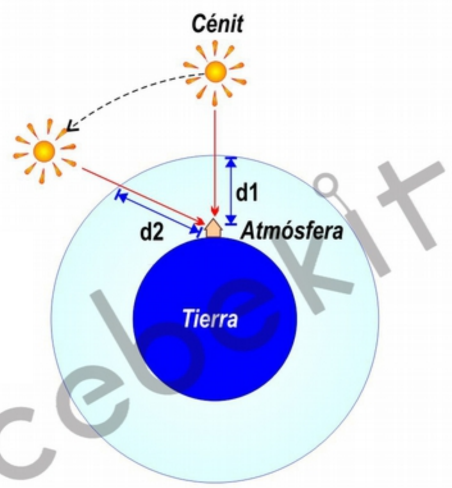
(*) This mean value ± 3.3% varies depending on the distance from Earth to the Sun .

The value of 1000 W/m2 corresponds to the power of solar radiation, called irradiance on a horizontal surface with the sun at zenith and completely transparent atmosphere. In the Mediterranean area (Eastern Pyrenees , Spanish Levante , Andalusia,.) This value produces a maximum power of 2000 kWh/m2 / year. In northern areas the value will decrease .
A basic photovoltaic cell will produce about 1 ~ 1.5 W when receiving a radiation of 1000 W/m2
(under standard conditions of radiation) . A photovoltaic module an area of approximately 0.5 m2 may be supplied , under optimal conditions , about 40 ~ 50W .

d1: thickness of the atmosphere with the sun at zenith

d2: thickness of the atmosphere with the sun declining

d2 > d1



Standard measurement conditions of solar radiation

To account for the effects of the atmosphere, defined the concept of air mass AM (AM = Air Mass , acronym in English) .
AM0 : Mass of air out of the atmosphere. The AM value is zero.

AM1 : Represents the standard thickness traversed perpendicular to the earth's surface atmosphere and measured at sea level. With a solar elevation angle of 90 ° : AM = 1

If the angle is 42 ° , AM = 1.5 . In laboratory tests of PV modules, always take the PM 1.5 value for the definition of the nominal power.

As mentioned before, the intensity of solar radiation on the ground depends on the angle of inclination of the radiation itself : the smaller the angle the sun formed with both the horizontal surface is the thickness of air that have to traverse , and therefore reaches a smaller radiation area .

The power of a photovoltaic cell varies with changes in temperature and radiation. In order to compare the different models have been established STC STC (Standard Test Conditions) , which define the so-called watt peak (Wp) concerning the power produced by the cell at a temperature of 25 ° C , under an irradiance of 1000 W / m² and AM1 condition 5.

technologies:

Current technology produces different types of solar cells. The most common for commercial use are:
Monocrystalline silicon. Part of a crystal of high purity. His performance is the highest but its manufacturing process requires high technology. It looks very uniform dark color.

Polycrystalline silicon or Multicrystalline . It is a cheaper alternative to single crystal silicon , its performance is lower. We distinguish at a glance how the different crystals.

Amorphous Silicon . By not present any definite molecular structure (crystalline) , the electrical performance and life is much lower than before. The resulting panels are cheaper but larger than the lenses of equal power . Being lighter , may be deposited on a variety of media such as aluminum, etc. . And even form flexible panels. These cells were first to be manufactured . They tend to be black but some manufacturers manufacture them in different colors.

With the multilayer and multi-junction techniques are achieving high efficiencies , but because of its price, for now, are limited to specific applications such as aerospace .
There are other technologies that use materials other than silicon , such as CIS , CIGS , CdTe , GaAs , Bfi , etc. .

Cells, modules and photovoltaic solar farms

As we have seen, the voltage of a solar cell silicon crystal is 0.4 ~ 0.5 V which is insufficient to power most electrical and electronic devices.
These cells, like other electric generators can be interconnected in series to increase the voltage and / or in parallel to increase the intensity of the current, to get the values we need for our application.
Manufacturers grouped several identical cells in the same structure and are marketed as photovoltaic modules or solar panels.

Crystalline silicon photovoltaic modules of various sizes, wattages and shapes

A module can also be connected together to form a photovoltaic garden, to achieve the desired power. Also usually installed on the roofs of houses, industrial buildings, sports centers, etc, for either partially or completely feed these facilities (especially in isolated buildings, away from the lines of distribution mains) or also to dump the generated energy to the mains, after having converted from direct current to alternating current.

The electricity generated by the PV, just as that produced by wind turbines, or that exploit tidal energy, etc, modules generate green electricity, so named because unlike produced from nuclear power, coal, oil or natural gas, is 100% renewable (inexhaustible), safe and non-polluting.

Photovoltaic Systems – Applications

Except for water pumping applications and toys, solar cells rarely connect directly to the application. In most photovoltaic systems need to have energy even in the hours that no sunlight (at night) or when it is low (rainy or cloudy days). Thus the solar module is connected to a 12V (or 24V). The number of modules used will determine the power of the system.

In addition to large gardens and sunroofs that aims to produce electricity to sell to the distribution companies, there are three basic types of solar photovoltaic systems:

Service. It is low power applications isolated from the network, such as pumping water for domestic or livestock use, repeater or radio telephone stations, battery charging in campsites, caravans, boats, autonomous lamps, emergency lights, warning signs etc..

Domestic or industrial systems connected to the grid (net balance). They usually have from several hundred W, to several kW. The electrical energy produced is converted to alternating current. The excess energy that is not consumed in the facility is turned over to the public grid and counted with a double counter that controls the energy entering and exiting.

Isolated systems (Stand alone or off-grid) for consumption. They are ideal for places where there is no electricity grid (holiday homes, bungalows, lodges, detached houses, barns, stables, RV, boats, etc. autonomous systems.

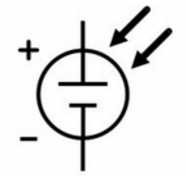
Typical applications

- Central to grid connected electricity supply.
- Photovoltaic Systems consumption
- Electrification of villages and households in remote areas (rural electrification)
- Power supply of medical facilities in rural areas
- Lighting of streets, roads , parks and roads
- Streetlights in private gardens
- Electricity supply for agricultural and pastoral huts
- Artificial Satellites
- Emergency Communications Systems
- Repeater Stations telephony , television and radio
- environmental monitoring stations and water quality data
- Lighthouses , buoys and beacons
- Pumping systems for irrigation , drinking water and water troughs for livestock
- Marking for signaling aircraft antennas and high points
- Desalination Stations
- Railway signaling
- Systems for recharging boat batteries
- Poles SOS (emergency roadside telephones) .
- Parking Meters
- Camping , bungalows, RV
- Recharging electric vehicles
- Refillers portable mobile phones, computers, tablets , etc.
- Calculators
- Toys

Solar cell and Concepts

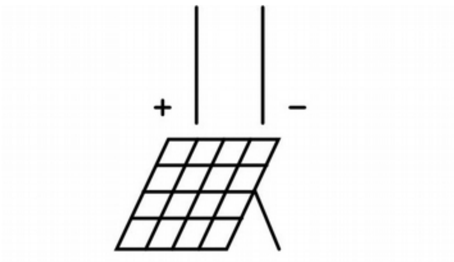
Essentially a photovoltaic cell is no more than a diode as it is a pn junction, with the particularity that its surface is very large compared with that of the rectifier diodes, and that receiving the impact of the photons from the solar radiation generates an electric current ..

As an electricity generator, its symbol is the same as the electric battery but circled. The two arrows represent photons from solar radiation.



Symbol of the solar cell

The electric batteries are formed by a stack of several cells, however often used symbol simplified. Both photovoltaic cells, such as small solar modules formed by few cells are also shown with the symbol shown above.
Solar modules consist of 24, 36, 72 ... cells are represented as follows:



Symbol module or solar panel

Same happens when you connect a battery, it is essential to connect the solar cells with the correct polarity. According to the manufacturer, the polarity may be taxed in the same cell. If wearing wires, the polarity is indicated by the colors of the wires. The most common are usually:

Red, white, yellow or brown = positive
Black or blue = negative

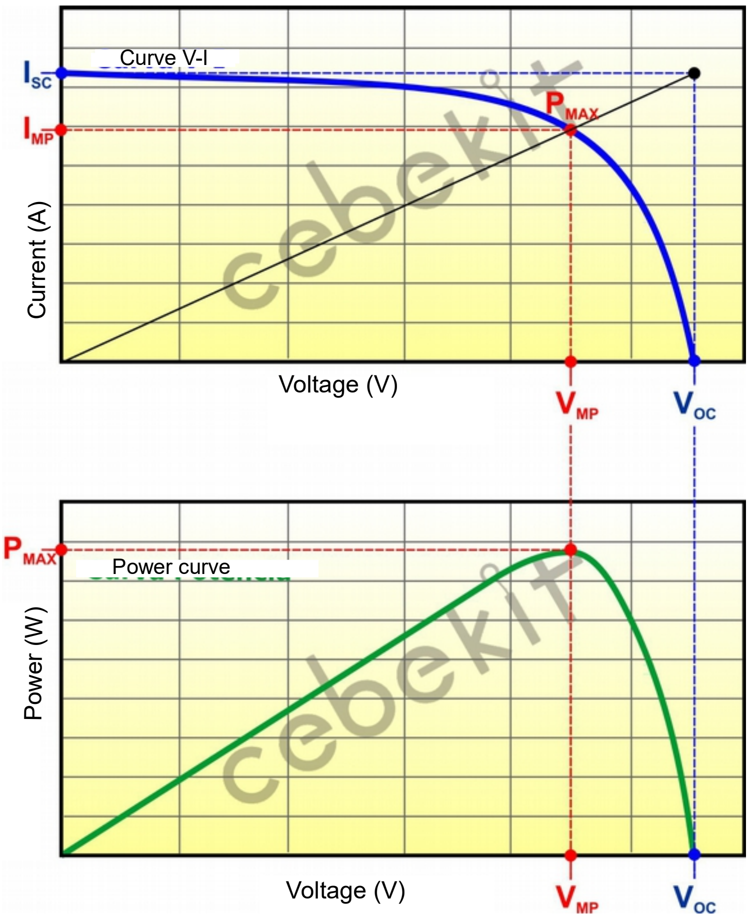
The electrical characteristic of solar cell

Solar cells behave as a current generator. Its operation can be described by means of the voltage-current characteristic VI.

In short circuit conditions the current generated is maximum (Isc), whereas when the open circuit voltage is high (Voc). Under both open circuit and short circuit power available shall be void, as the result of the formula of power:

$$P = V \cdot I$$

in both cases will scratch. In the first case because the current will be zero and the second will the tension.



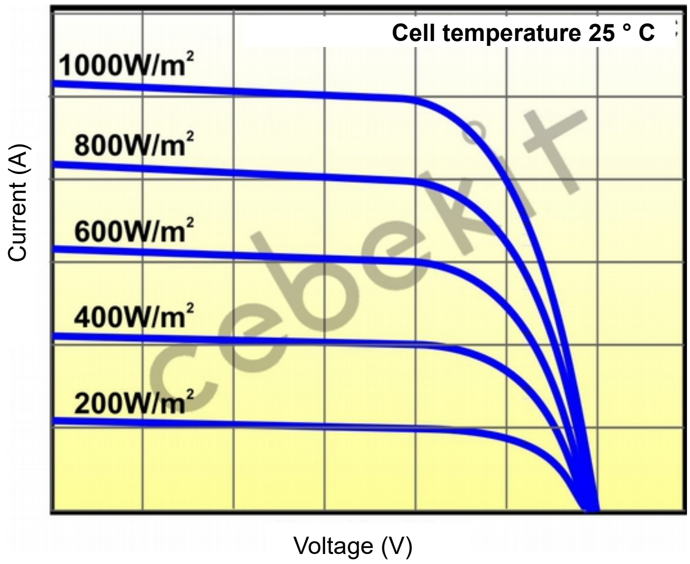
In the other feature points VI, increasing the voltage increases power, reaching its maximum value and decreasing sharply when approaching the Voc value.

This is the formula of the maximum power:

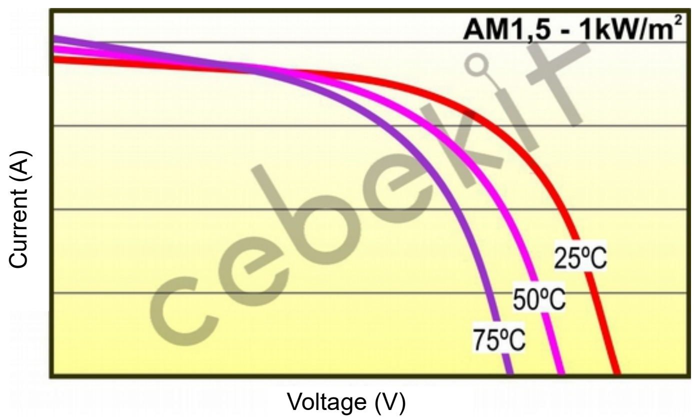
$$P_{MAX} = V_{MP} \cdot I_{MP}$$

The VI characteristic depends on three key variables:

• The intensity of solar radiation. Affects only the current but not the Voc



• The temperature. Decreases with increasing voltage Voc



• The surface of the cell. No impact on voltage, but at higher output current greater surface and therefore more power.

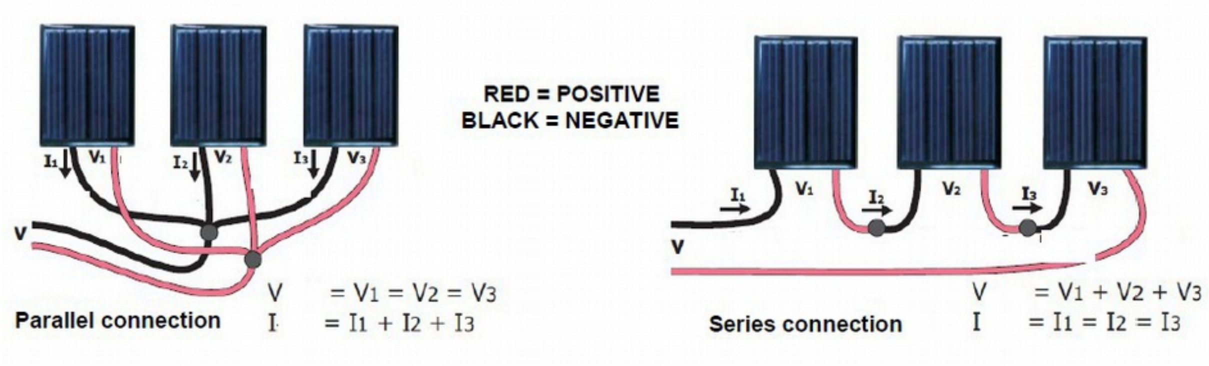
TONC

TONC (Nominal Operating Temperature Cell) concept appears in many sheets of solar modules and refers to the temperature reaching the solar cell module when subjected to an irradiance of 800 W/m2 with spectral distribution AM 1 5 G, the ambient temperature is 20 ° C and the wind speed of 1 m / s.

Solar module C-0137

Miniaturized photovoltaic solar cells and high performance . They are ideal for classroom practice technology electricity, electronics , crafts , robotics and any mounting that sets a very high performance and reduced cell size.
See our catalog various special solar motors that can be driven directly by these cells.
Mounting and installation . For cell fixation is recommended double-sided tape on the back.
Preferably a tape with spongy base.
The cell should be positioned facing the direct sunlight . Its performance depends on the illumination received .

It can run inside , if the cell is illuminated with an incandescent lamp , halogen preferably . Not suitable for fluorescent lighting or compact fluorescent lamps.
Connection . Photovoltaic cells can be grouped according to the connections "serie " , "Parallel" and " mixed" .
When connecting two or more same cells in series , the resulting voltage is the sum of all of them and the intensity of the current is the same for all .
When connecting two or more same cells in parallel, the voltage is the same for all , being the intensity of the resulting current equal to the sum of all intensities .
By serial, parallel or mixed connections is possible to obtain voltage and current we require .
It is very important to respect the polarity indicated in the diagrams .



LED

LED is the acronym of its name Light Emitting Diode .

This is a semiconductor device that emits narrow-spectrum light (mono-color) when polarized directly the PN junction and is traversed by an electric current.

The color of the emitted light depends on the semiconductor material used in manufacturing the diode.

Currently there are many formats and types of encapsulated LEDs. Those used in this kit are known as round Ø5mm LED.

The foil covering the LED is plastic resin and may be diffuse or transparent depending on the desired light effect. The color of the plastic used to differentiate only when turned off does not influence the light emitted.

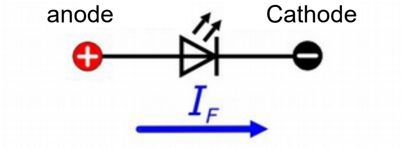
LED symbol

History :

The British experimenter and radio pioneer Henry Joseph Round discovered the phenomenon of electro-luminescence in 1907.
The Russian scientist and inventor Oleg Vladimirovich Losev published in 1927 the first informative study on the LED. In the period 1924-1941, published a series of articles explaining the functions of the device he had developed.
The American Professor Nick Holonyak, Jr. the father of the current LED is considered as published in 1962 by SF Bevacqua, the announcement of the creation of the first LED emitting light in the visible spectrum. In 1963 he predicted almost 50 years before that as your LED would improve the quality and efficiency to replace incandescent lamps TA Edison.

Identification of terminals:

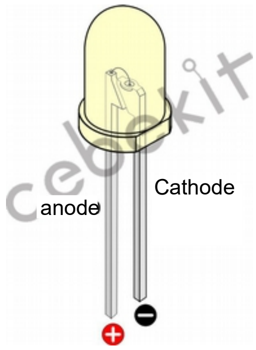
As the LED is a diode, its terminals are the anode and cathode. You need to properly polarize the diode drive current and light emission. To do this you have to apply the positive to the negative anode and the cathode.



Direction of current

The cathode is distinguished by being the shortest terminal and be with the flat side of the rim of the cup. If we look inside the capsule see that the cathode has a much larger and the anode is where the PN junction is located.

We can also identify LED terminals using multimeter on "diode test" position. By connecting the positive terminal of the multimeter to the anode and the negative cathode, the display will indicate a specific value for few moments. If you connect it backwards infinity mark. If the ambient light is not high also can see that the LED properly connected to the multimeter emits a faint light, due to the current test.



Electrical parameters:

The LED only works when connected in the forward direction with DC.
It is necessary to calculate the current pass through the LED for correct light intensity without destroying the LED.
Here are the features of the technical specifications that may interest us to calculate the Position:

Absolute Maximum Values:

P_{AD} **Absolute maximum power:** The power limit that can dissipate without destroying the LED. To calculate the power dissipated our LED apply this formula

$$P_{AD} = V_F \cdot I_F$$

V_R **Reverse Voltage:** The maximum voltage that can withstand the LED in reverse, ie applying the positive to the negative cathode and the anode. An error in polarity voltage higher immediately destroy the LED.

I_{AF} **Maximum Forward Current:** We should never exceed this value, after which the LED is destroyed. If the source can supply a higher current, we limit inserting a series resistor.

Electro-optical characteristics:

V_F **Forward Voltage:** The voltage drop causes the LED to be traversed by the test current shown (in this case IF = 20 mA). A typical value and a maximum value. VF will use the value of the chip for power calculation and possible limiting resistor

The other electro-optical data indicated under certain test conditions (in this case IF = 20 mA) and include :

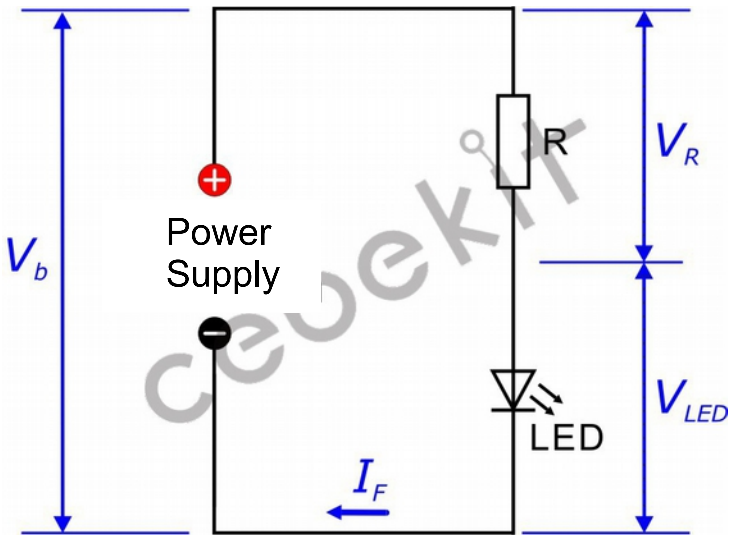
λD : Dominant Wavelength: is measured in nanometers (nm) and refers to the color of the emitted light.

2θ1/2 : Angle of half intensity: measured in degrees and indicates the opening angle of the light beam. For a better understanding see the viewing angle curve, the next page of the record.

Iv : Luminous intensity: its unit is the lumen (lm) and refers to the level of light emitted by the LED.

Calculation of the limiting resistor:

As stated above we must protect the LED from exceeding the maximum allowed using current limiting resistor "R" to connect in series. See the basic diagram of an LED connected to a power source either.



In this scheme it holds that:

$$V_b = V_R + V_{LED}$$

Thus the voltage across the resistor will be:

$$V_R = V_b - V_{LED}$$

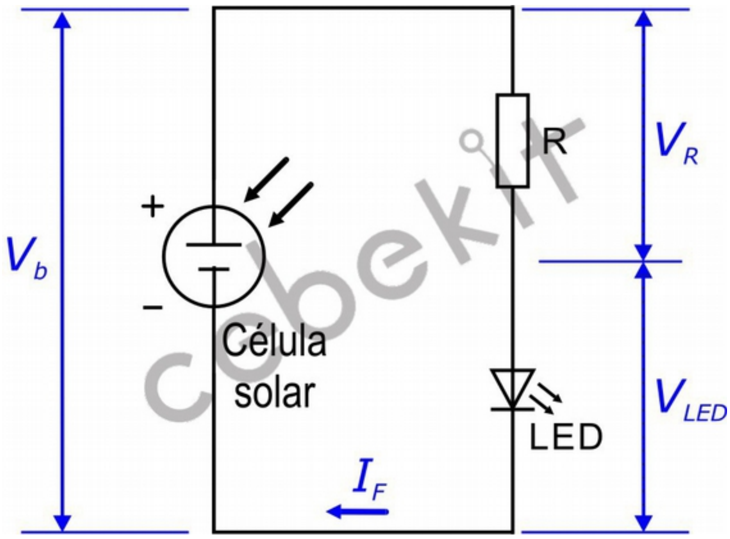
Applying Ohm's Law we can calculate the resistance value:

$$R = \frac{V_R}{I_F}$$

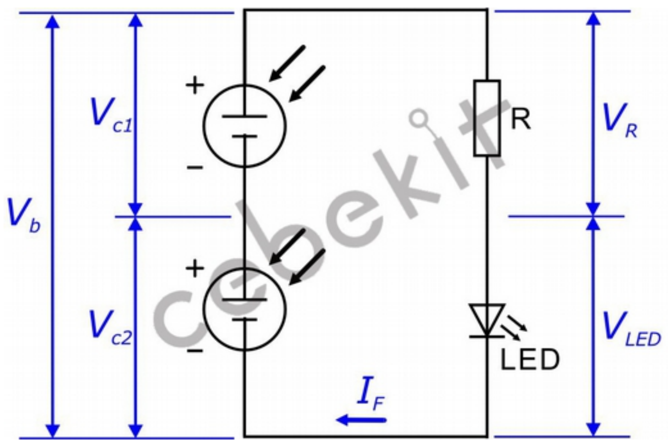
This would be the formula adapted to our application

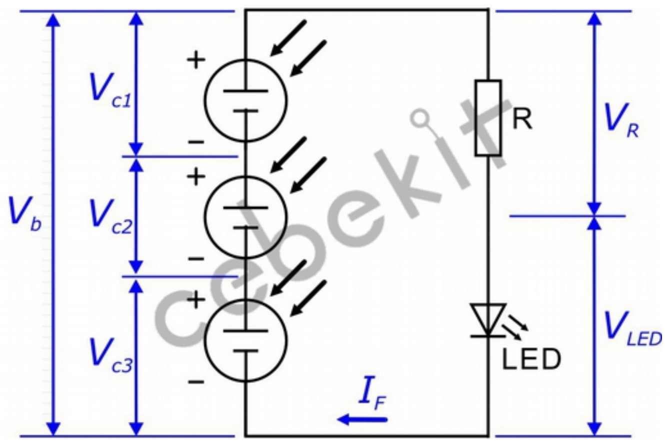
$$R = \frac{V_b - V_{LED}}{I_F}$$

In our case, the power supply will photovoltaic solar cells.



If we need a higher voltage to turn on the LED, we can go so many connecting solar cells in series as needed:





Data for the calculation of the formula:

$$R = \frac{V_b - V_{LED}}{I_F}$$

V_b : will result from the sum of the voltages of all the cells connected in series

V_{LED} :take the (typical) chip value corresponding LED

I_F : LED brightness depend on this value, but we know that we should not in any case exceed the maximum absolute value (IAF) 30mA indicated on the record. Ideally take 20mA, which is the reference value in the data record. In the case of using a lower value (eg 10mA) LED function but also less bright.

Powers:

Do not exceed the maximum power (PAD) that can dissipate the LED. We can verify this by applying the formula for power:

$$P_{AD} = V_{LED} \cdot I_F$$

To calculate the power of bleeder resistor apply the formula:

$$P_R = R \cdot I_F^2$$

Resistances:

The unit of electrical resistance is the ohm , and refers to the resistance of a conductor by applying a voltage of 1 V (volt) a current of 1 A (ampere) flows .

The resistance values are normalized and are different series.

These are the basic values of the E12 series, which is the most current. Multiplying 10-2 , 10-1 , 10, 102 , 103 and 104 derivatives values are obtained .

E12 series : 100-120 - 150 - 180-220 - 270-330 - 390-470 - 560 - 680-820 Tolerance: 10%

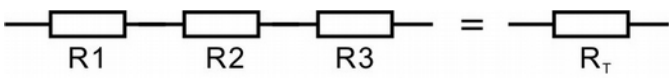
There is another series of greater precision as the E24 (5%) , E48 (2%) , E96 (1%) and E192 with intermediate values , but such precision is not required for many applications such as the kit.

When we calculate a value determined adapt to the nearest standard value . If for example the result of the calculation is 940 ohm , we use a 1000 ohm resistor (usually indicated 1k ohm)

When we dispongamos a certain value can combine different resistances in series, parallel or series-parallel simultaneously .

Resistors in series :

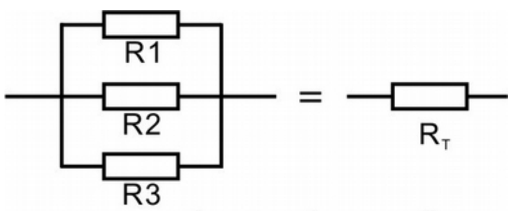
Add all values



$$R_T = R1 + R2 + R3$$

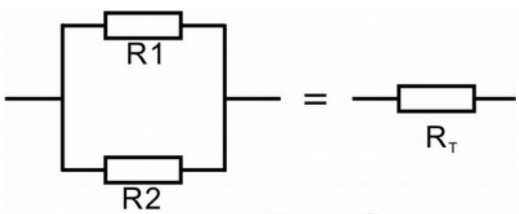
Resistors in parallel :

Converses all values are added



$$R_T = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$$

In the case of two resistors in parallel we can use the shorthand:



$$R_T = \frac{R1 \cdot R2}{R1 + R2}$$

The photovoltaic effect
Currently the most common solar cells are silicon .
For making them are part of a cylindrical silica glass obtained by melting . This crystal is doped with a small amount of impurities which make it electrically conductive . If a crystal doped with phosphorus is obtained
"N" (electron-conducting) . If doped with boron , a crystal "p" (host of " holes" or positive charges) is obtained . The glass is cut into very thin wafers of fractions of a millimeter.
To manufacture a solar cell with " pn junction " , wafer " n " is used in its surface and boron is melted at high temperature , obtaining a thin layer "p" . This is the face that will be exposed to solar radiation.
When a " photon " (elementary particle of light) of solar radiation strikes the " pn junction " a pair " electron-hole " is generated. The electrons will tend to move towards the region of silicon "p" . If we connect a few wires in the regions "p" and " n", the electric current produced will flow through us to connect the electric appliance business (motor , light bulb, LED , etc ...) .
The photovoltaic system is characterized by having no moving mechanical parts , and fluid flow , nor any fuel , for being a clean and fully sustainable energy. The need for silicon
manufacture of photovoltaic cells is , after oxygen , the most abundant material on Earth .

Solar radiation
Solar power is continuously emitted by the sun in the form of radiant energy. The level of solar radiation
received in the atmosphere of the Earth is 1353 W per square meter. Through the atmosphere, and due to the absorption of the air layers that form, maximum solar radiation we measure on Earth at sea level, with a cloudless sky and when the sun is at the highest point, is 1000 W/m2. The closer we get to Ecuador Earth, solar radiation is greater because more sunlight coming through perpendicular and have fewer layers of air.

Cells, modules and photovoltaic fields
The photovoltaic cell is the basic element of a solar installation . The voltage produced by a single cell is only suitable for very small core applications . If interconnect many of the same cells in the same structure will have a photovoltaic module. Most modules consist of 36 cells.
Modules can also be connected together to form a PV array and achieve the desired power. It is what we can see on roofs of houses or holiday homes in roofs of factories or large buildings, and large installations of " solar farms " , which are actually large power plants producing energy called " green " because its production is based on solar energy that does not pollute or exhausted .
Solar cells is usually sealed with clear resin to protect them from moisture and contamination. The solar modules are usually mounted on an aluminum frame and protected with a head- prestressed glass , anti-reflective .

Installation and Maintenance
It is essential to properly choose where to be installed each solar module. It depends on system performance. The panel should be facing the sun as long as possible. The best situation is looking at noon (south in the northern hemisphere). Another important consideration is that it is not affected by the projection of any shade of buildings, trees or other nearby elements.
The only maintenance required is to remove the possible leaves or dirt deposited on the front, as can reduce the surface energy harvesting. Small cells will be cleaned with a soft, dry cloth.

Mounting the motor group

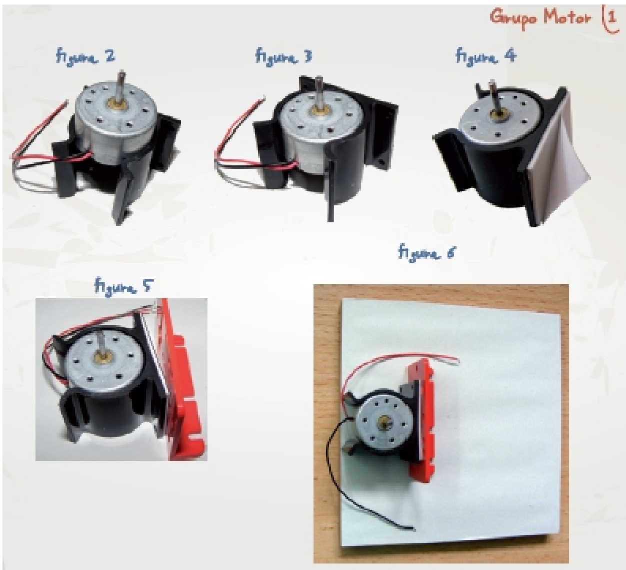
Enter the motor in pressure support entering it, but making sure that the wires are in the open part of the clip (Fig. 2).

The engine should be flush to the support given by the output shaft (fig. 3).

Now you must attach this assembly to the mounting bracket, for that you have to put a pad centered on the narrow base of the post. Remove the protective backing from the adhesive bracket motor (Fig. 4).

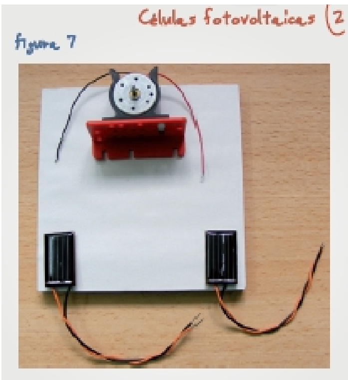
Supports the corner on a flat surface on its narrow base, do the same with the engine and connect them (Fig. 5).

Remove the protective sheet from the pad the bottom of the bracket and engine set fixed in the center of one side of the base (fig. 6).



Installation of photovoltaic cells

Sticking an adhesive pad on the back of each of the two photovoltaic cells.
Remove the protective sheet and the cells fixed in opposite to the motor (fig. 7) corners.
The cells are mounted away from the engine to rotate the propeller blades do not shadow on the cells.



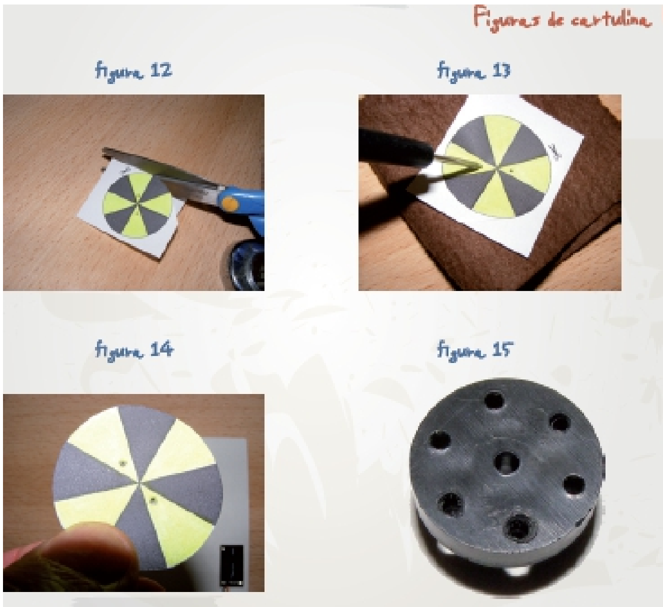
Mount propellers

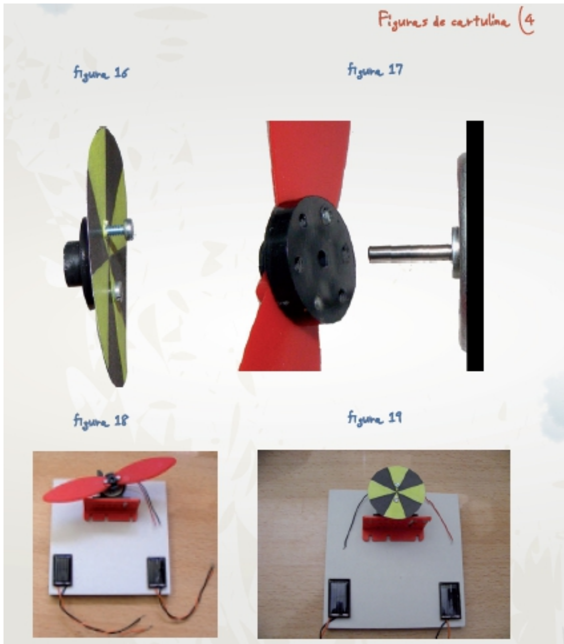
Locate Part nº 5, 6 and 7 (Fig. 8). Place the blade on the hub in the position shown and secure it with M2 screws (Fig. 9). Then the other fixed blade (fig. 10). Once mounted the blades must be perfectly aligned (fig. 11).

Assembling the cardboard figures

Please note, children must perform the following operations under the watchful eye of an adult and use appropriate safety scissors .

Choose the shape you want to ride on the rotor hub . Cut cardboard carefully (fig. 12) .
Place the figure silhouetted on a punching pad , a felt or a folded towel , and with the help of an awl , toothpick or similar "click " carefully marked the two points in the drawing, to open the two holes where must pass the screws (fig. 13 and 14).
Place the hub with the flat side up (fig 15).
Put the figure outlined above and secure it to the bushing through the two holes through the two M2 screws (fig. 16) .
This system allows to exchange figures or blades , as you wish . Can you make your own designs on a card and then color them to your liking, you cut them and secure them to the hub rotor with two M2 screws kit.
To mount the rotor in the motor hub have to be inserted under pressure into the shaft of the motor (fig. 17 , 18 and 19) .

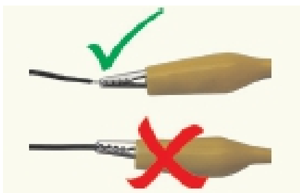




Already have prepared your own photovoltaic laboratory. When the sun look you can experiment with solar energy.

Preliminary considerations

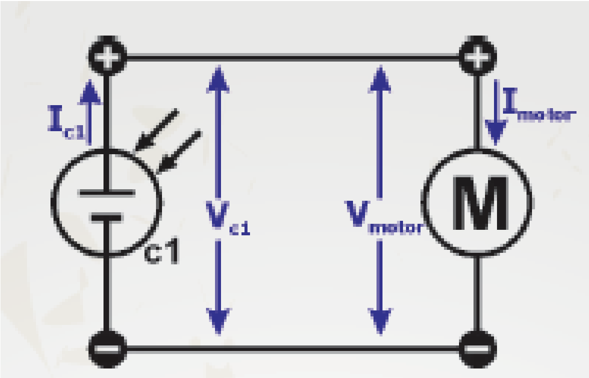
The experiments indicated below show how claim photovoltaic cells generate electricity from solar light. You will learn in a fun and entertaining ways to connect different way.
To make connections and be able to make changes quickly and easily should use flexible cords equipped with alligator clips containing the kit. Pay attention that the clamp is making good contact with the cable conductor and is no longer clamping sleeve of insulating plastic.

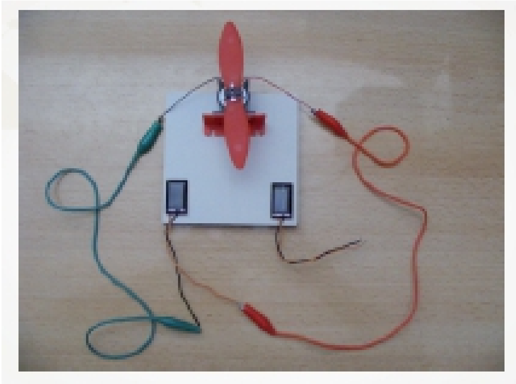


Experiments will only work properly when the cells are in direct sunlight.
Even in sunny or semi-sunny days, the results of the experiments can vary significantly depending on the level of solar radiation each time. Cloudy days can conduct experiments in class or at home if you light the cells with a lamp equipped with a 100W halogen bulb, 50W or perhaps even it out.
According to the experiment, you must ride on the rotor hub single engine, propeller blades with 1 or 2 or the various drawings printed card stock with the kit or you can even put your own designs.

Practice 1 - Motor connected to 1 solar cell

To view properly if the motor is running will need to insert the rotor hub on the motor shaft.
Use wires with alligator clips to make the connections.
Connect the red wire (positive pole) of one of the two cells, the red motor wire and the black wire (negative pole) in the same cell, the black motor cable. Place your solar laboratory under the direct sun.





What is it?
If the cell gets enough sunlight, the motor will rotate.

Why?
The solar cell generates electricity when it receives sufficient solar radiation level. The voltage generated by the cell is 0.5 ~ 1 V (depending on the level of light received). The engine of this kit sensitive starts from approximately 0.5 V, as long as the cell can supply about 25 mA direct current. If the engine mounted propeller or other contraption would need more power to start.

Proposed experiments to be performed in the same facility

Practice 2

Put your solar laboratory in direct sunlight and watch the motor turns.
With an open hand about 50cm away from the cell connected, try the shadow of your hand to project on the cell unbeatable direct sunlight.

Why?
Not receiving enough solar energy, the cell can not produce enough electricity to run the motor.

Repeat the same above but with the fingers of the hand very separate action. Place your hand at the right distance to the shade of a light finger tape cell. Now move your hand slowly under the sun, so that the cell receives moments of sun and shade moments. Observe and draw your own conclusions.

Practice 3

Follow the mounting of the propeller (see section Installation, Item 3). Once assembled insert it into the engine. Put now under direct sun cell.

What is it?
If the cell gets enough sunlight, the motor will rotate. Surely the engine speed will be lower cost or boot.

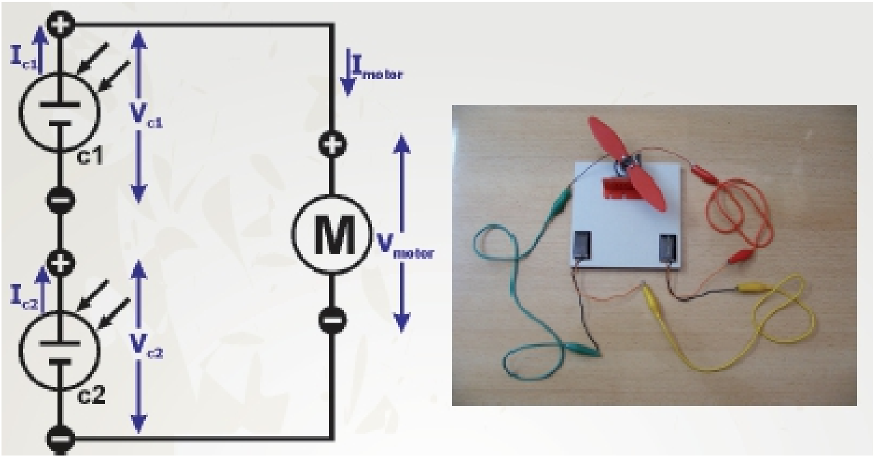
Why?
The propeller is a burden on the engine, weight and windage by rotating the motor require more energy than in Experiment No. 1. Depending on the level of solar radiation that have the cell can not generate enough power to drive the motor.

Practice 4

Remove one of the propeller blades. Observe what happens and think that may be the cause that provokes it.

Practice 5 - Motor 2 solar cells connected in series

Use a cable with alligator clips to connect the red wire (positive pole) of one of the two cells, the red motor wire. With another cable clamps connected the black (negative pole) of the same cell to the red wire of the second cell. The black wire from the second cell should connect with the third wire to the black wire with pliers engine.
Install the propeller on the engine Put the cells in direct sunlight.



What is it?
If cells receive enough sunlight, but the motor will turn faster than in the previous case.

Why?
When connecting two cells "in series", the voltage to the motor is the sum of the voltage of each cell. As the two cells are equal, the motor voltage in this production is double that received in the experiment num.3
Vmotor = c1 + V c2
Moreover, in a connection "series", the intensity of the current flow through the engine is the same as flow through each of the cells.
Imotor = Ic1 = c2

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

Proposed experiments to be performed in the same facility

Practice 6

Remove one of the propeller blades and compare the results with the experiment num. 4
Remove the blades and compare it to the rotor hub alone. Quick Tour else? Why?
You can propeller replace the cards with drawings and notes and compare the different results.
When cardboard mounts with cutaway drawing of the three-bladed propeller, first test with flat blades, then with the blades angled to the left and then inclined to the right.
Try to draw your own conclusions.

Practice 7

You must install from the experiment num . May .
Once you've tasted and observed well away your sun photovoltaic laboratory so that the cells do not produce electricity (if you prefer covering the cells with an opaque cardboard or a thick cloth). Now disconnect the alligator clips that are connected to the two wires of the motor and connect them as follows:
The red wire (positive pole) which is free from the first cell must now connect the black motor cable and the black wire of the second cell (negative pole) must connect the red wire from the motor.
Put the cells in direct sunlight .

What is it?
See detail if anything has changed .

Why?
The motor rotates in the direction of clockwise (clockwise) when the red wire (positive pole of the motor) is connected to the positive pole of the power system , in our case the cell.
The motor rotates in anti -clockwise to reverse the polarity (swapping the motor wires) sense.

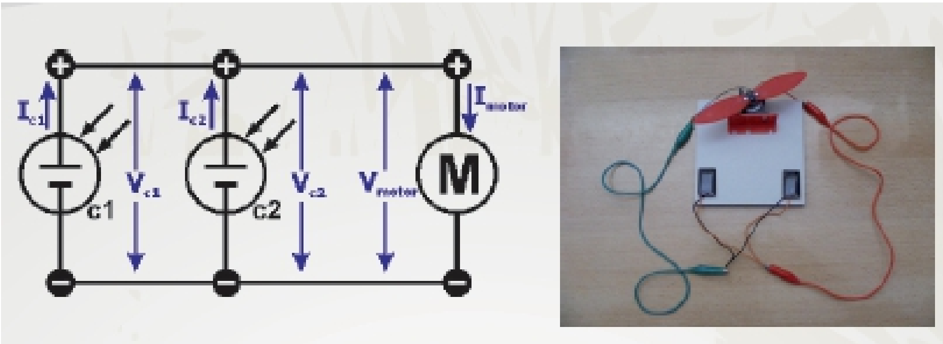
Practice 8

You must install from the year num. 5, ie the motor is connected to the correct polarity. Put the mounting in the open sun to rotate the motor.
How helix behaves as a fan or as an extractor? You can observe it well loose small pieces of very thin paper on rotating propellers.
What happens if you reverse the polarity as you did in the experiment num. 7?
When you have observed well what happens, remove the mounting sun (or covering the cells with an opaque cardboard or cloth thick) so that cells do not produce electricity. Now unscrew the two blades and re-mount them upside down, or if you prefer, remove the propeller shaft and insert it upside down.

What happens now?
Look carefully, think and draw your own conclusions.

Practice 9 - Motor 2 solar cells connected in parallel

Connect the red wire (positive pole) of the two cells with one of the alligator clips on the cables. clamp
Alligator other end of this cable must connect the red wire from the motor.
Now another cable with alligator clips, do the same with the negative poles of the cells and the black cable motor.
You just make a connection "in parallel" in this type of connection all the same poles are attached (with positive positive and negative to negative).
Install the propeller on the engine Put the cells in direct sunlight.



What is it?
Does the motor spin faster than a single cell (experiment 1) ? Does it turn faster than the two cells connected in series ?
Remove one propeller blade . Does it work better or worse than in Experiment 4 ? And regarding the experiment num . 6 ?
Substitute Helix by different cards and compare the results with those of the same experiments with cells connected in series.

Why?
Connection " in parallel" can only be done with cells having the same voltage. When connected "in parallel" all voltages are equal and the engine receives the same output voltage of the cells, so the motor is the same voltage as in the first experiment you did with a single cell.
Vmotor = c1 = V c2
So what gives us the parallel connection ?
The intensities of the currents produced in each of the cells are " attached " to get to the motor cable , which means that the motor will receive the sum of the intensities of the first and second cell.
Imotor Ic1 + c2 =

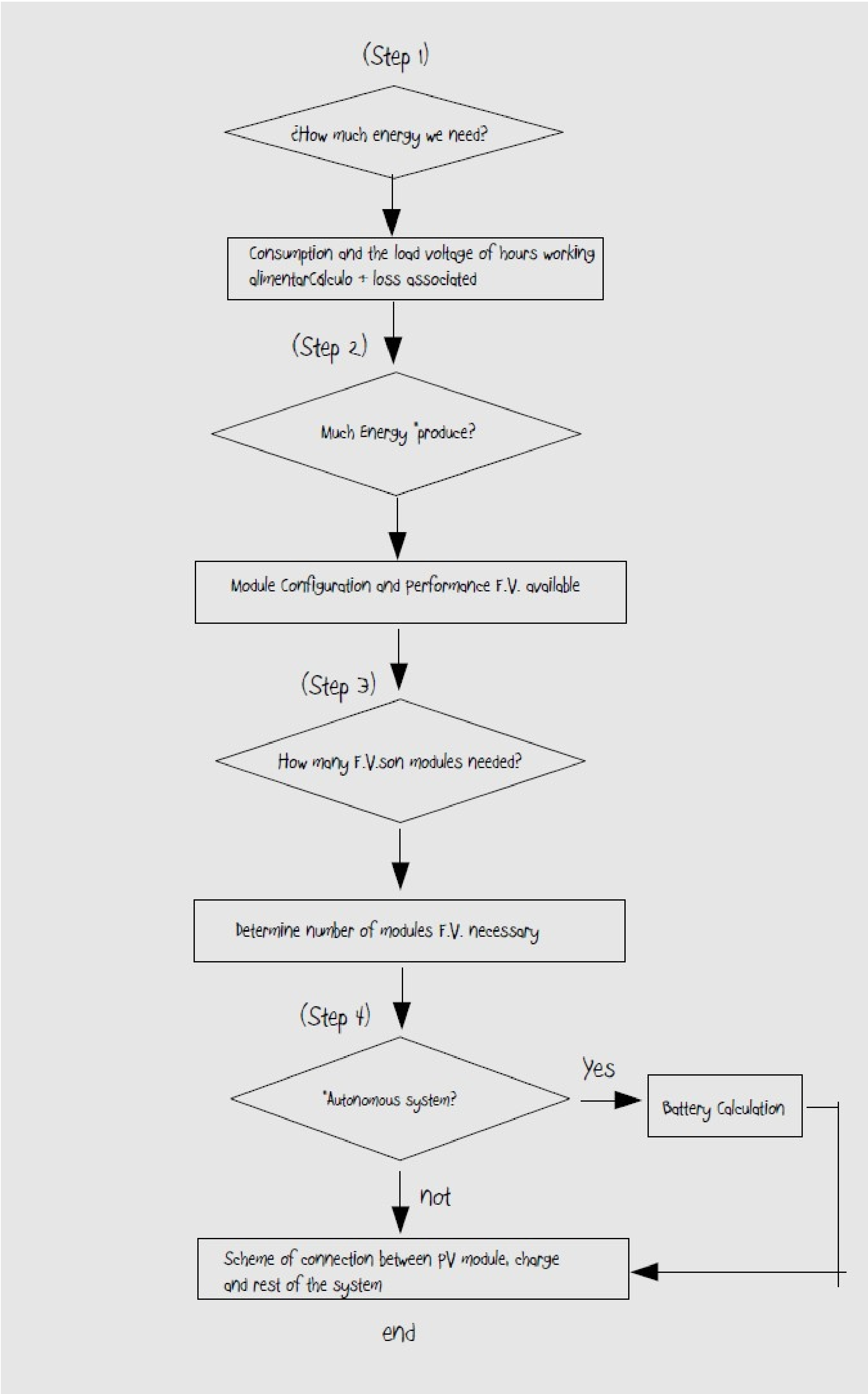
In our case you will not notice much difference as you motor is high efficiency and requires very little power to operate. In other words, the motor speed depends on the voltage. The intensity of the current demand when the engine itself requires more effort.

Summary.

When you want to use electronic devices that require more voltage than that generated by a single cell can be grouped "series" as many cells (equal) as necessary to achieve the required voltage. The maximum amount of current that can absorb the device is equal to the maximum that can produce a cell.
When you want to use electronic devices that require high current which can produce a single cell can be grouped "in parallel" many cells (equal) as necessary to reach the current
Required. The output voltage is the same for all, that of a cell.
You can also do a mixed connection (series and parallel combination) of the same cells to achieve current and voltage we require.
You can buy sets of 4 cells and this kit under the reference C-0137. We also have higher power models.

Designing a solar PV system

A photovoltaic system is modular and unlimited, the more interconnected solar cells, increased energy production, and so does the panels.
As described in "My Notebook Solar", the serial or parallel connection of different modules (cells or panels), is set to increase the voltage or current output. Regardless of the values provided by the module photovoltaic (PV) solar system is always designed under the same chart.



We will use two examples to follow and explain the chart.
Example 1: solar motor 1.5V and 200 mA. Example 2: computer battery charger and 3V 100 mA.

Step 1. How much energy do we need?
The first step is to set the power supply and consumption (current / current) , electrical appliances have to supply the system . These values are obtained through the data provided by the manufacturer.

Tension. During the entire time that they stay in operation , the voltage level and will be a constant.
Each sample is fed to a different voltage . The first motor , 1.5V , while the second , the charger , 3 V. When the voltage required is different for different devices , will establish an independent Solar "line " that all computers will be connected the same voltage (voltage) supply.

Consumption . Indicates the current " spend " each time the appliance . The engine of Example 1 will consume 200 mA / h . By contrast , the current from the charger of Example 2 is only 100 mA / h .
For every new computer connected to the same línia (same tension) , must be added the consumption of each . If in Example 1 , in place of one, two motors are used, the result would be 1.5 V./400 mA . (sum of consumption, voltage equal) .

Power . Described as " my solar notebook " is the product of voltage and current . Sometimes the manufacturer rather than the consumer , provides the overall value of the power . I still need to clear the formula to get the current value .
Therefore, the energy required for the motor of Example 1, a voltage of 1.5 V and a power of 300 mW would correspond .
The energy required in the charging of Example 2 is 3 V and 450 mW.
The energy required can also be quantified based on consumption , as reflected in the values of the statement of each example (1.5 mA V./200 . V./100 and 3 mA.) .

Loss factor . Although in practice this kit is negligible in solar installations which contemplates the daily intake is important . (explained later in more detail, along with the condition of the running time) .

Security warnings

- Classroom activities for learning practices in educational settings made under the supervision of an adult instructor.
- This product is NOT A TOY.
- Not suitable for children under 3 years due to small parts which may be swallowed.
- Before starting installation and practices, it is necessary to have read and understood this manual.
- It is essential that children use it under the close supervision of a qualified adult for it.
- Take necessary safety precautions to avoid injury when handling kit components or with sharp edges and / or sharp points that any of them could have.
- When this product or its components are no longer in use, DO NOT DISPOSE OF TRASH. Store in a collection point for electrical / electronic equipment for recycling.

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