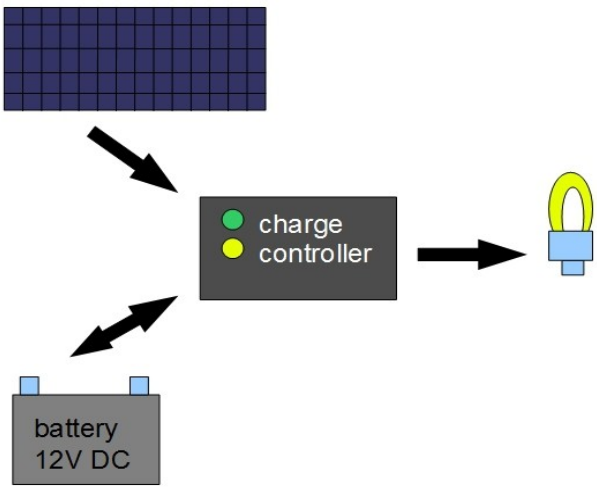
Construction manual 'smart lamp' MULTI LED

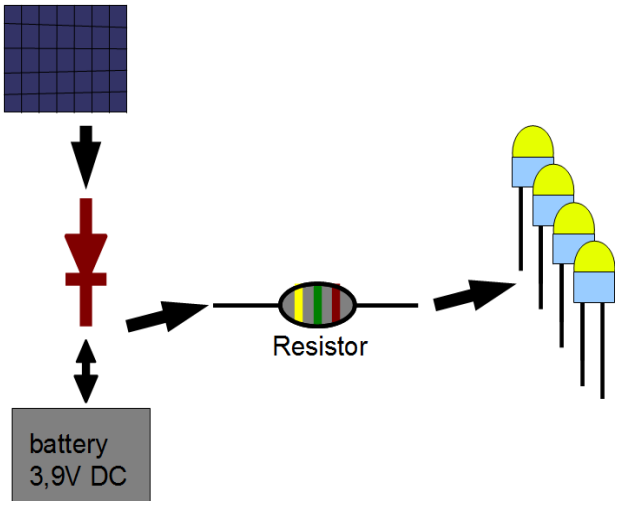
(Both '4 LEDs' and 'TURBO' versions)

1. Introduction

The small solar flashlight 'smart lamp' is the reduced size model of a complete photovoltaic system. It contains the same components in their most simple version: a solar panel, a (rechargeable) battery (made out of 3 cells), an appliance (the LEDs), a charge controller (= a diode):



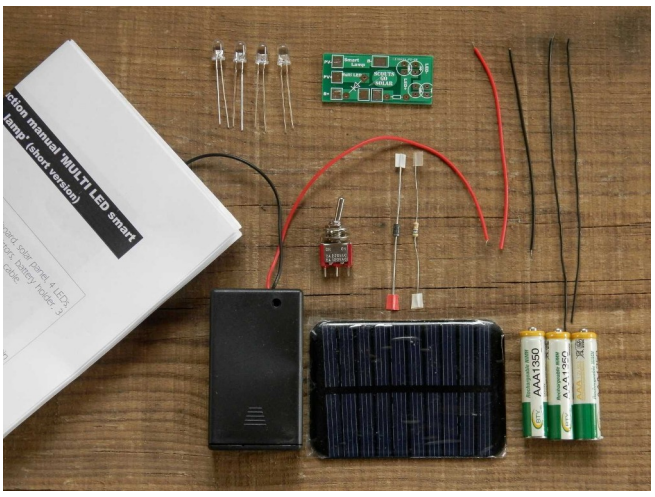
Elements of a PV system.



Elements of the 'smart lamp'.

The lamp is intended to be a tool for teaching/training: in the end of an introduction to solar energy, every participant builds his/her own flashlight.

2. The kit



The kit contains: PCB board, solar panel, 4 LEDs, switch, diode, 5 or 10 Ω resistor, battery holder, 3 NiM:H rechargeable batteries, wires.

What you need as well: a soldering iron, tin (electronics grade), possibly soldering paste, a heat resistant working surface, small tweezers, a nail clip or cable stripper.

Warning: the LEDs are very strong, never point it directly towards your eyes or someone else's face!

3. Soldering in general

Soldering is a method to join two parts of metal (copper, iron, ..) with the help of a third metal of a lower melting point (tin). The contact is mechanically solid and contacts electrically. **The most important rule**: *first* heat both parts with the soldering iron, (only) *then* add the tin.

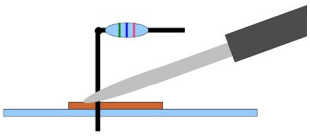
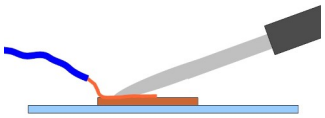
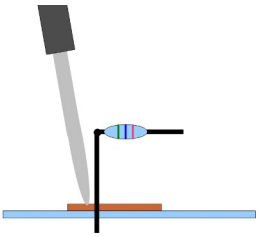
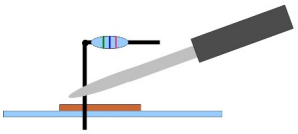
In electronics, many times we fit so called PCB boards (plastic boards with thin copper lines) with components. Until a few years ago, the components were inserted trough holes from one side and soldered from the other side. Nowadays, components are soldered on the same side as they are placed, the so called 'surface mount'. Our lamp is soldered in the second way.

Soldering, step by step:

1.Both metal parts must be clean (if they aren't, clean them with alcohol or file the surface if oxidized).

2.You *might* add soldering paste. This removes a possible layer of metal oxide. For our lamp, it is hardly needed. If you use paste, remove its leftovers at the end using alcohol.

3. Join both parts **with gentle pressure** of the hot soldering iron. For best heat transfer, we do not use the tip of the iron, but the side of the tip, holding it slightly inclined.

			
a) Good: iron heats component and copper layer.	*b) Good: iron heats wire and copper layer.*	*c) Bad: The contacting surface is very small, the iron should be held inclined.*	*d) Bad: the iron hardly touches the copper layer, no pressure is applied.*

We encounter two cases of soldering in our lamp: sometimes, we insert the 'legs' of a component trough a little hole and join 'leg' and cooper layer (a), some other times, we lay the 'stripped' end of a wire on top of the copper layer and join them (b).

4. **Only when both metal parts are very hot**, we add tin, from 'below' if possible. In theory, the tin does not touch the soldering iron, but only the parts to be connected. These parts should be hot enough that the tin melts by touching them. The soldering iron is not a brush 'paining' liquid tin!

5. Now we wait a little moment, until the tin forms a nice 'drop'.

6. We fix the position of our components for instance using a knife, screw driver of a small file and remove the soldering iron.

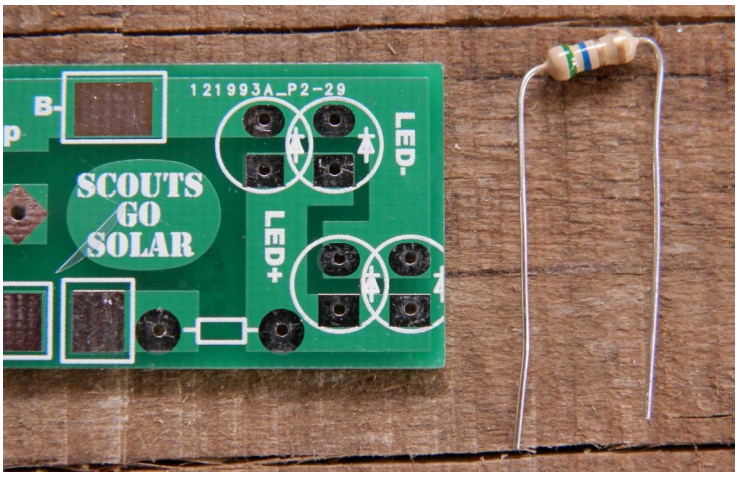
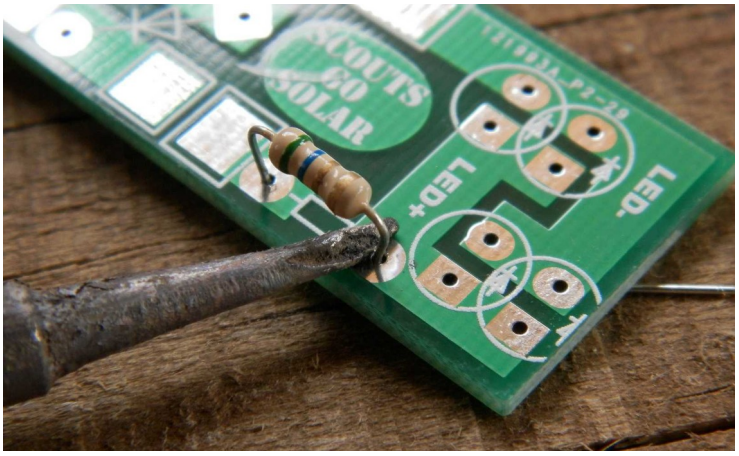
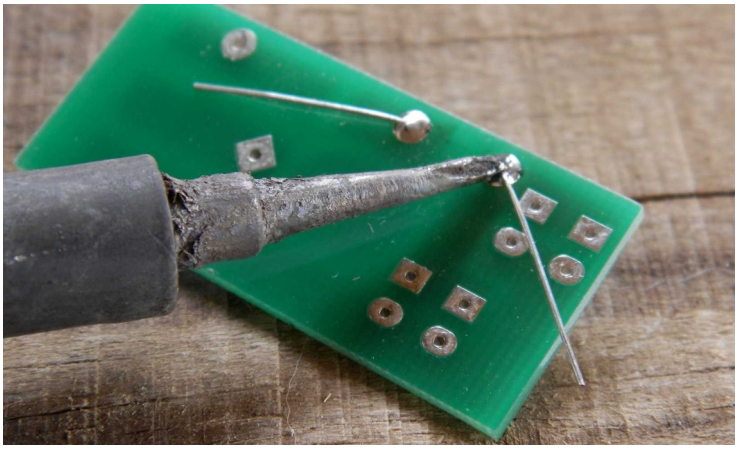
7. After a few seconds, the tin is solid and we can remove the knife, etc.

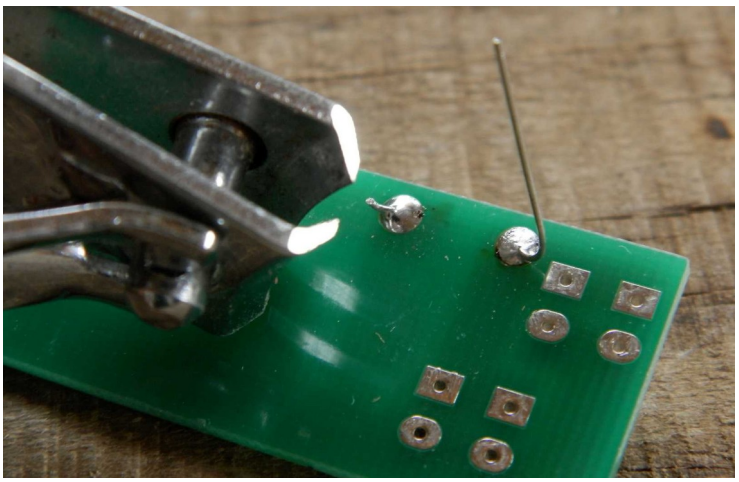
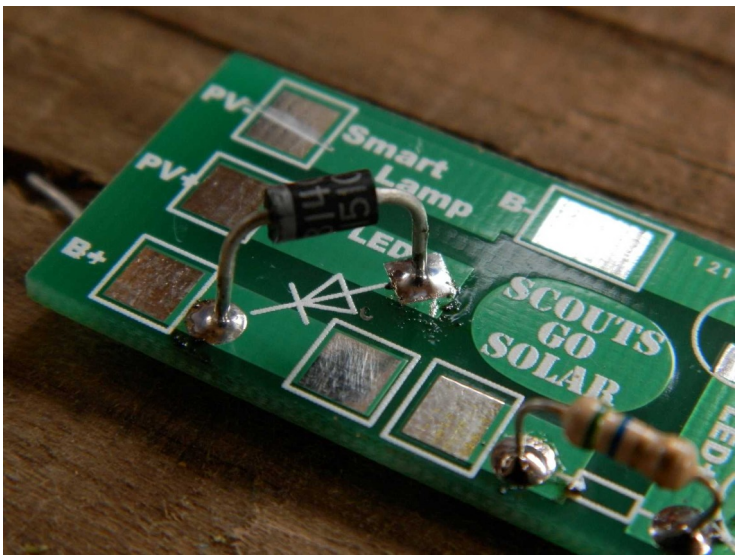
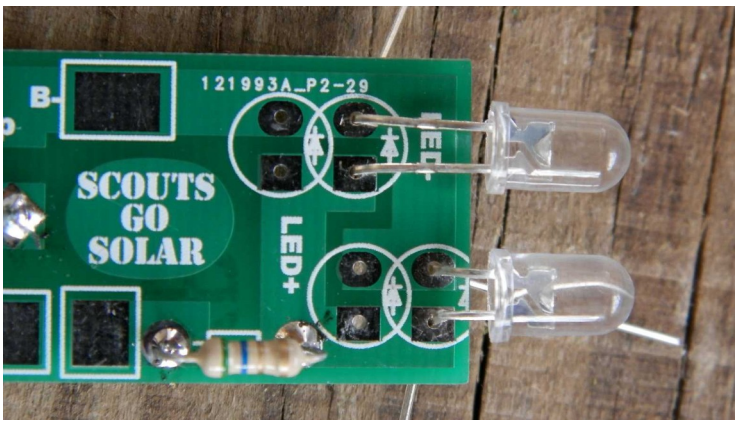
8. To check our solder joint, we gently pull the soldered element: if it holds mechanically, the electrical contact is usually OK as well. We also give it a 'visual inspection'. If we are not happy with the result, we heat the solder joint again.

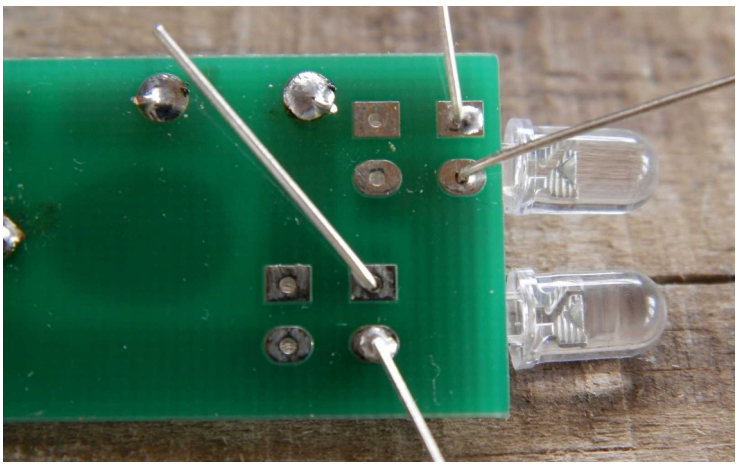
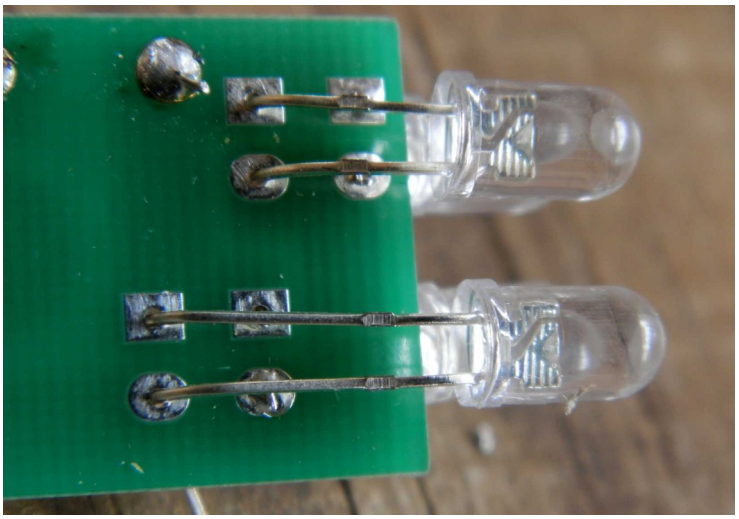
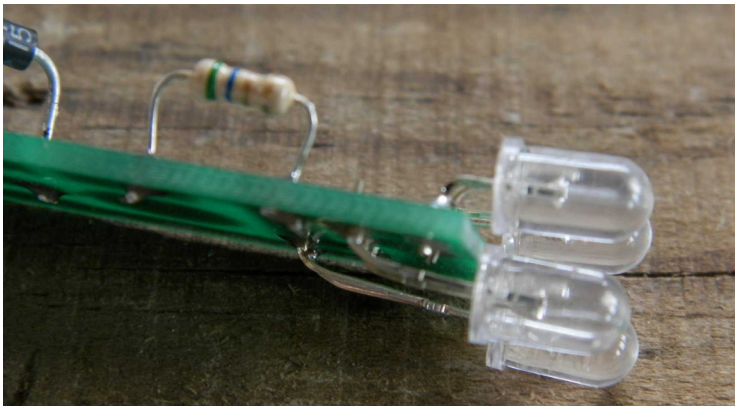
Soldering needs at least 3 hands! We best start working in pairs. Later we learn to get by with our two hands, smartly exchanging our tools..

4. Let's go!

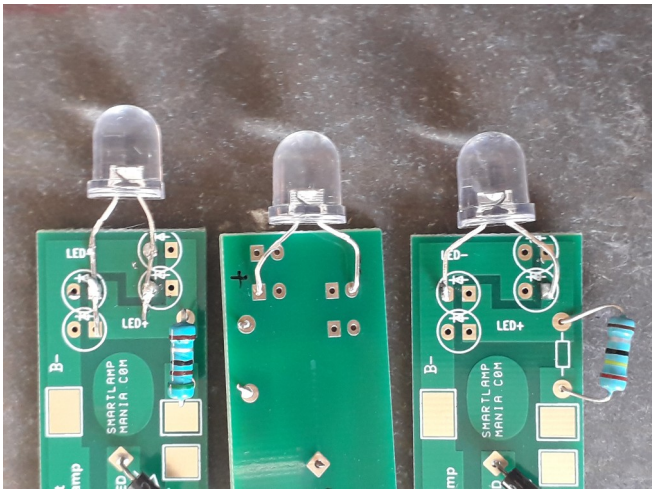
Now we start soldering part after part:

	The first element to start with: the resistor. Its function is to slightly reduce the voltage in order not to 'burn' the LEDs. We bend it like shown in the picture.
	We stick the 'legs' of the resistor trough the holes below the 'SCOUTS GO SOLAR' printing. The resistor has no polarity, it doesn't matter in which direction is looks. We bend the part of the legs sticking out to both sides to fix the position while soldering and solder on the top side as shown in chapter 3.
	If we prefer, we can also solder from the back side. This holds true for the diode and the LEDs as well.

	After soldering, we cut the part of the wire sticking out with a nail clipper or a wire cutter.
	Our 2nd element is a diode, it avoids electricity flowing back from the battery to the solar panel at night. We bend it like we did it with the resistor. The diode goes into the two holes near PV+ and B+. The diode is 'polar', the side with a grey ring points toward the corner (near B+, round pad). Bend the legs outwards below the board. Solder and cut as above.
Now we install the LEDs. If your kit contains 4 smaller LEDs, follow the next four pictures, if it contains one larger LED (‹TURBO› version), skip these 4 pictures.	
	Let's install the LEDs. They have a longer leg (positive / + / plus) and a shorter one (negative / - / minus). We start with the two LEDs nearer to the small side of the board. We insert them into the holes indicating LED+ (a square) and LED- (a circle). With each LED, we leave a distance between its head and the board which allows that – after bending by 90° - the transparent head is about 1mm beside the edge of the board.

	We bend the part of the legs sticking out to both sides to fix the position while soldering. Now we solder either on the front side or on the back side of the board and cut as before.
	Now we install the second pair of LEDs. These LEDs stay below the board (see also next picture). We stick the legs into the holes remembering that the longer, positive leg goes into the square pad and the shorter, negative leg into the circle. After bending by 90°, the head of the LED should be 1mm beside the board like the other pair. We bend the part of the legs sticking out to both sides, solder on the back side of the board and cut as before.
	With the four LEDs in place, the board looks like this.
If your kit contains one larger LED (‹TURBO› version), follow the next two pictures, else skip them.	

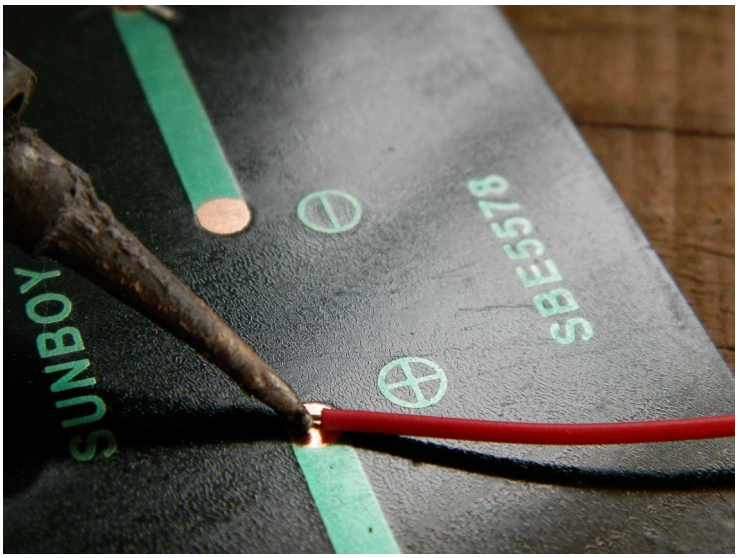
	The LED has a longer leg (positive / + / plus) and a shorter one (negative / - / minus). We mark the longer / positive leg, bend both legs as shown in the picture and shorten (cut) them.



Now there are several ways to attach the LED by soldering:
Center and right side: We push the legs of the LED trough two of the holes marked 'LED' (the positive leg trough a hole with a square soldering pad, the negative leg trough a hole with a round pad – either from the lower side upwards (example in the centre) or from the upper side downwards (right side). We solder as before.
Left side: We can also lay down the LED flat on the PCB board and solder each leg to one or two soldering pads. Be careful: the positive leg can only touch square pads, the negative leg only circular pads.

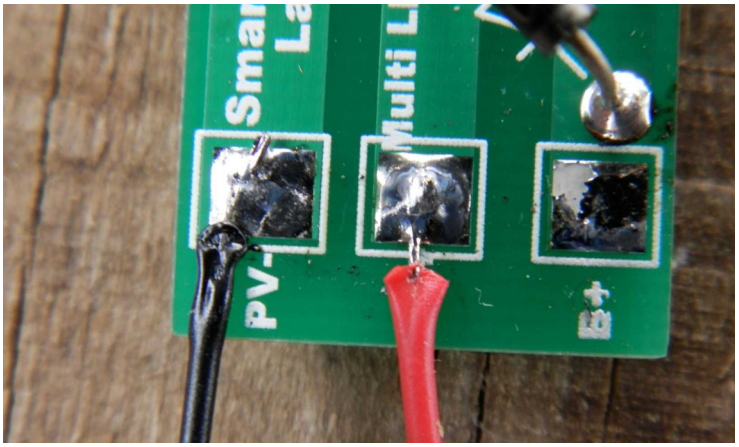
From here on both types of kits follow the same manual again.

For the next steps, we need the bits of wire. If there is an end of a wire still covered with plastic, we have to 'strip' it. This means we remove about 5mm of the plastic shield using a knife, scissors, the nail clip or even our fingernails.



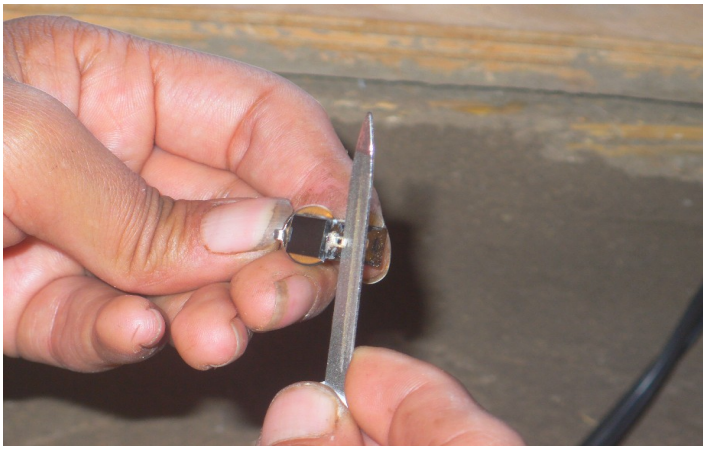
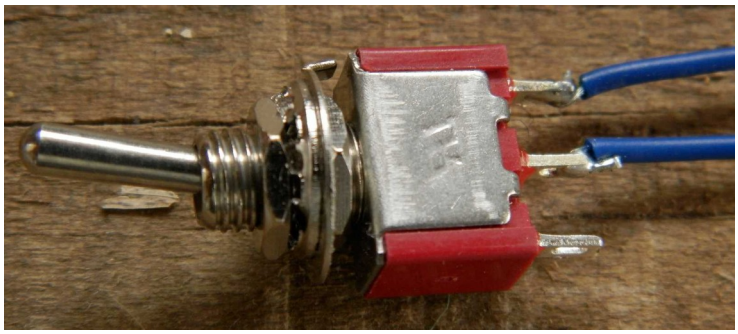
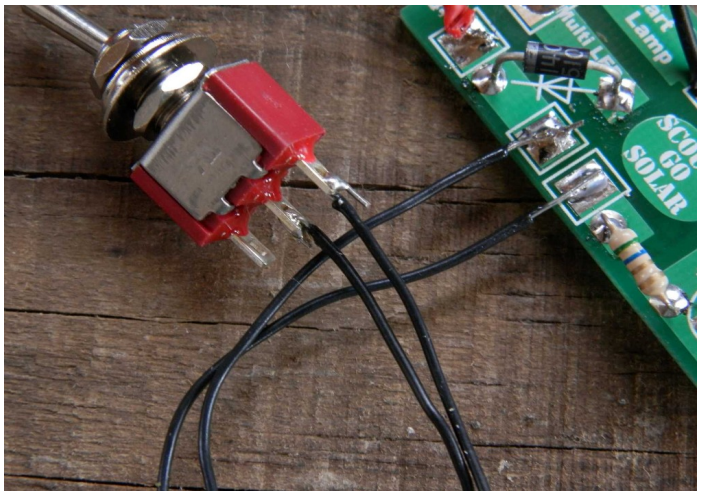
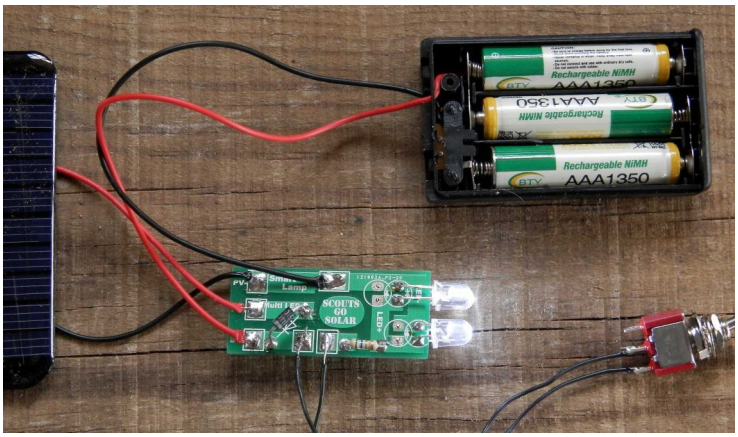
The solar panel needs wires for contacting. We solder a red wire* to the + contact of the panel and a black one to the – contact. Soldering is done according to the method b) in chapter 3, i.e. by pressing the wire endings to the contact pads of the panel, heating both for a few seconds and finally adding tin.

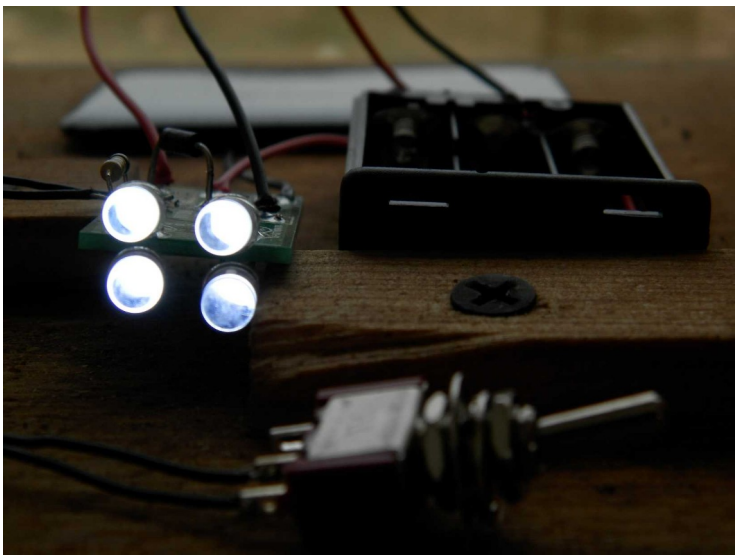
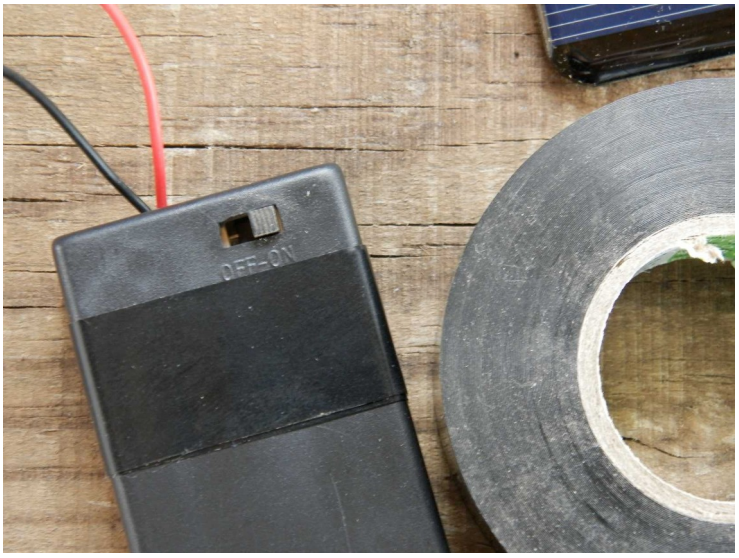
* (If we have red/black wires.. Else another colour does it as well.)



Solder the wires of the solar panel to the pads PV+ and PV- of our board.
(The red wire connects + of the panel with PV+ on the board, the black one – of the panel with PV- on the board).

(Put the wires first through your lamp housing if the solar panel is outside and the board inside.)

	Our most difficult task in soldering: add two wires to the switch. The switch **contains plastic parts**, we cannot heat it for more than **3 seconds**, else it melts! To permit fast soldering, we look for a perfect preparation: we might file the contact 'fingers' of the switch with a nail file, we stick the wire through the small holes and twist them and we use soldering paste (if available). If your switch has 3 contacts: use the middle one and any one of the outside.
	Heat the 'contact finger' of the switch and the wire for **not more than 3 seconds** with the soldering iron, adding tin **at the same time**.. If your are not happy with your soldering, just wait for a moment and try another 3 seconds..
	Solder both free wire ends to the board as shown on the picture. It does not matter which wire to which side.
	Only one part is still missing: the box for the rechargeable batteries. We connect the (empty) box to the board: red wire to B+, black wire to B- .

	After a final checking of all solder joints* we try the circuit first *without* battery: We put the solar panel near a window. In one of the two positions of the switch, the LED must light (might be very dim). * Gently pull on all parts and wires and give them an visual inspection as well. If you are not sure about a solder joint, just heat it again; usually it does not need any additional tin.
	If all is OK, we insert the batteries in their box and prevent it from opening with a scotch tape. **The battery box has it's own ON/OFF switch, keep this one always in ON position. Else the solar panel cannot charge the batteries!**

If the battery was delivered in a charged state, the lamp is ready to work! **But be careful: never watch the light beam directly, the LEDs are very strong! And never point it to someone else's eyes!**

If there was no light with batteries inside the box, put the lamp (or the solar panel, to be precise) for a few minutes into the sun and try the switch. If there is still no light, the switch was probably in the wrong position while charging (and all electrify directly went into the LED): try charging again keeping the switch in its other position.

In any case, it is useful to put the lamp for a few hours in full sunlight to give the battery a complete charge to start with.

A few words about charging:

It needs the charge of at least two hours of sunlight for one hour of LED light. With brand new and completely charged accumulators, we have at least 6 hours of electrical light. If we charge the panel behind a window, charging takes a little longer. Strong daylight without direct sunshine charges as well, but slower. Indoor light from light bulbs is usually too weak for charging.

The rechargeable batteries are designed for 1'000 charges. Nevertheless, such information is 'to take with a pinch of salt': each time they keep a little less charge and they do not like getting hot at all. The hotter they get

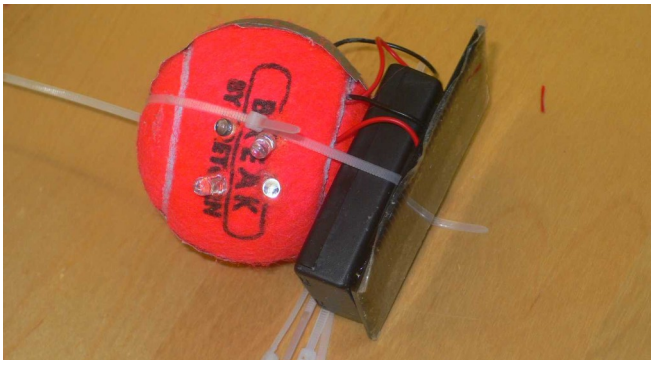
at charge in the sun, the shorter is their lifetime. **That is why we advice to only charge the lamp with direct sunlight if it is empty**. If you keep the lamp inside near a window (but not in direct sunlight), it might get enough light to never run down completely.

You can replace the batteries if needed with any brand of the same type (NiM:H) and the same size (AAA).

5. The lamp case

There is no limit to your imagination for giving your lamp a case! You can use transparent plastic boxes, PET or shampoo bottles, bamboo, wood or any box of sweets, pills, matches, ... Just drill a hole of a diameter of 6mm for the switch and a larger one for the light to pass or the 4 LEDs to stick out. And find a way for the solar panel's wire to enter the box. Better do not use a very small box: the battery gets hotter while charging and has a shorter lifetime. You might use longer wires for panel and switch or even connect the LED with wires in order to separate LED, battery, board and switch in your lamp.

Some ideas for your lamp case*:

* find more ideas on our facebook page.

If you have questions, write to smartlamp@cusinesolaire.com or check www.facebook.com/SmartLampMania

Why not uploading a picture of your personal model on 'smartlamp mania' on facebook? We would be happy!

Have fun with your solar flashlight!

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