Lithium Heavy Duty Solar USB Charger 2.0

by **JoshuaZimmerman** on November 12, 2013

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I used to teach middle school science, but now I run my own online educational science website. I spend my days designing new projects for students and Makers to put together.

Intro: Lithium Heavy Duty Solar USB Charger 2.0

Sometimes you need a whole lot of solar power to get your gadgets going. Bigger phones, tablets, and gadgets mean that they're more power hungry. When normal DIY solar chargers fail you, you need to turn to a Heavy Duty solution.

In this project I'm going to show you how to create a Lithium Heavy Duty Solar USB Charger. It's the second version of this project and addresses a lot of minor issues while improving the overall design. The key highlights of this project are it's 5W Solar Panel, 3A dual USB output, a powerful Lithium Ion Battery, and a laser cut wooden case.

Due to the parts being used, this project is suitable for direct solar to USB charging and could easily be used day to day. It's something that could be used for light camping or be used in an emergency situation. It's internal battery is more than powerful enough to charge any cell phone up at least once, and lesser phones/ gadgets several times. The only downside to this project is that the laser cut case is not waterproof, though it is very rustic looking.

Most of these parts can easily be found online, or at least very similar parts. I have a full Lithium Heavy Duty 2.0 Kit available on my website. If you're looking for a smaller project, try the Solar USB Charger 2.0 Kit. If you just want something pre made, then grab a Folding USB Solar Cell.

Note: This is not a beginner Maker project. Lithium Batteries can be dangerous. Practice doing some other projects before doing this one.

Difficulty: Easy - Medium
Cost: Medium - Less than a store bought at the same power
Time: 30 - 60 Minutes

Step 1: Parts

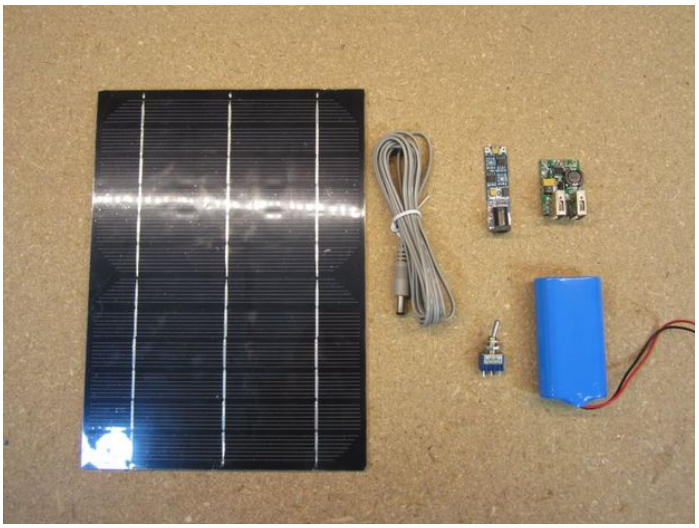
All parts to this project can be found at BrownDogGadgets.com. A complete kit is available as well.

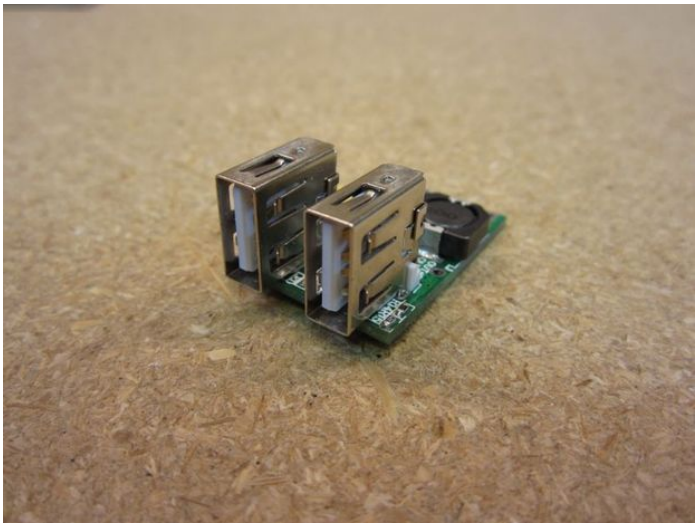
Parts:
USB Charging Circuit - DC to DC Boosting Circuit
3.7V Lithium Battery Charge Controller
3.7V Lithium Battery - 2600mAh or better
6V 830mA Solar Cell (5 Watts)
2.5mm Male Barrel Jack with Wire
Toggle Switch
Wire

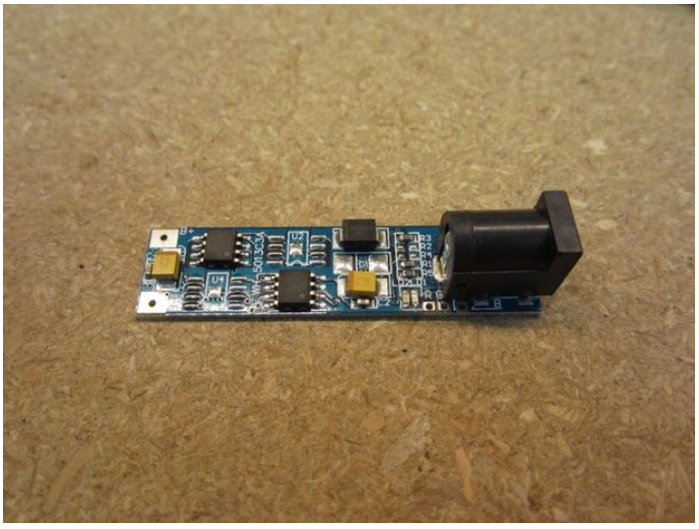
Laser Cut Case Parts:
Laser Cut Box
16 X 6-32 Screws
16 X 6-32 Nuts

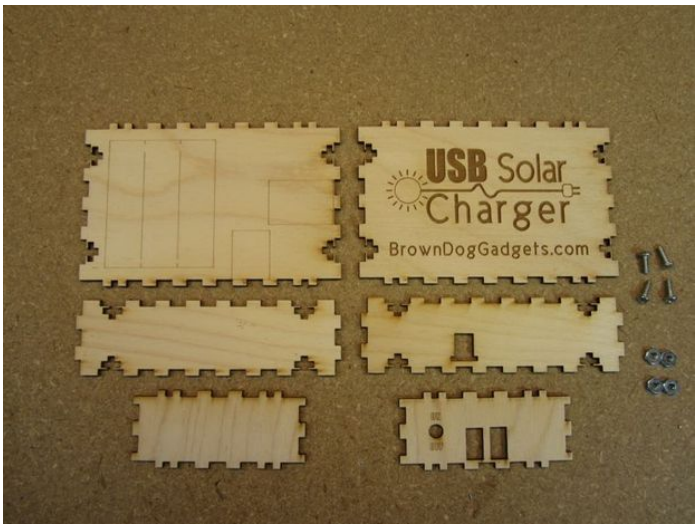
Tools:
Soldering Iron
Solder
Hot Glue Gun
Foam Tape
Wire Cutter
Wire Stripper
Screw Driver

Optional Tools:
Helping Hand
Scissors









Step 2: USB and Lithium Circuits

Lithium Charge Controller

Lithium batteries are found in most high tech gadgets. They pack a powerful punch at a small size and affordable price. The downside is that they can be unstable. Like all batteries Lithium batteries use a chemical reaction to store and release energy. Unlike a AA battery when a lithium battery has problems, you have problems. Occasionally fires have resulted, though seeing how there are billions of lithium gadgets out there and very few fires, the risk is very small. (Think about that next time a cell phone goes in your pocket.)

To make sure our Lithium Battery is safe we're using a Lithium Charge Controller. Some variation of this is found in every lithium powered gadget. The controller makes sure that the battery is getting the exact voltage it needs to charge. It also prevents overcharging and under charging of the battery. This is something that is very essential to our project.

The circuit also can tell us when the battery is charged up. A red LED on the board tells us the battery is charging. A blue LED tells us when the battery is full.

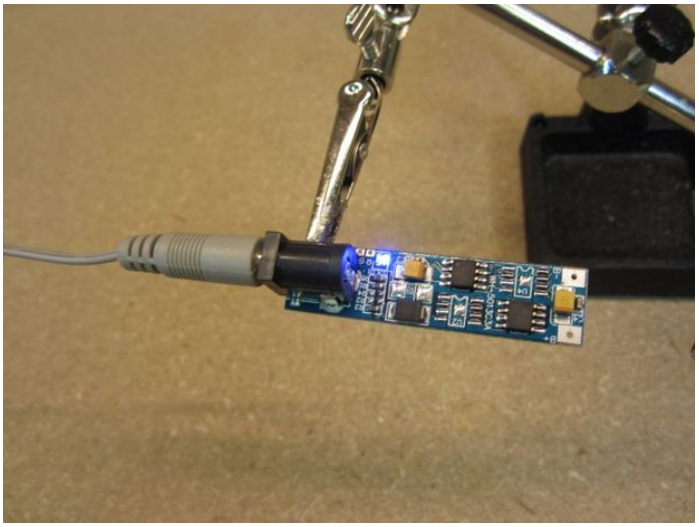
USB Circuit

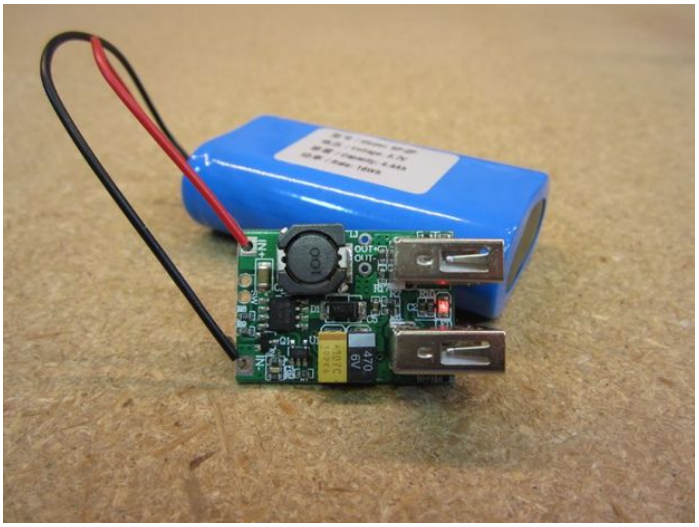
Typically there are two ways to make a solar circuit. One is to take a very high voltage and drop it down to the 5V needed for USB. The other is to take a lower voltage and boost it up to USB.

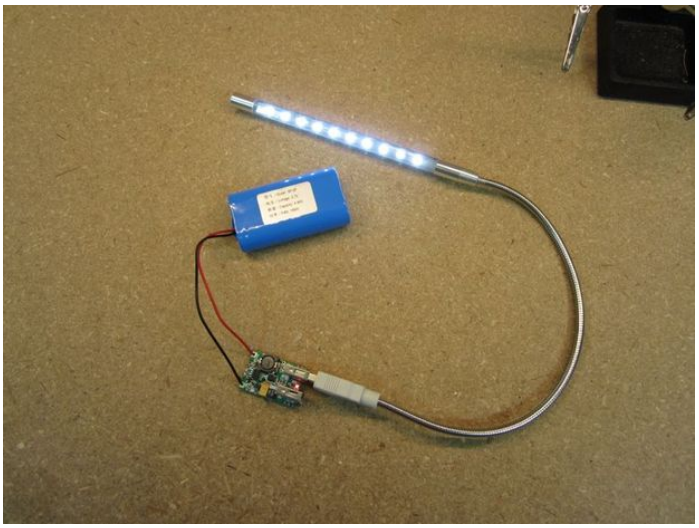
Our Lithium Battery only puts out 3.7V, and isn't enough to charge a USB device. Our USB Circuit acts as a small transformer, using a coil of wire to boost the voltage up to 5V. We get a higher voltage by sacrificing amperage. You'll find a similar circuit inside any device that uses a lithium battery and outputs USB power.

There are many circuits on the market, but this one is a beast. It has an output rating of 3A that is shared across two USB ports. Thank to the lithium battery behind it we're able to achieve charging speeds equal to any wall adaptor, as well as charge even the most power hungry gadgets.

In this case our circuit can output 3A of power shared across both USB ports. Which means you can charge two gadgets at once, and both gadgets will be getting 1.5A of power. Your standard USB wall adaptor or desktop computer outputs around 1A, and laptops about 0.5A.







Step 3: Solar and Battery Power

Battery Power

As explained before we're using a 3.7V Lithium Ion Battery. You'll find the same type, or very similar, inside pretty much any gadget or laptop you own. These batteries require an input voltage of between 4.5V and 5.5V to charge. Less and they won't charge. More, and they... get very dangerous.

In simple solar USB projects AA batteries are used as a cheap and safe power source. The biggest difference when using Lithium batteries is that they hold a much higher charge. Meaning you can charge your gadget longer. They're also able to output power faster than AAs, which also helps charge things up faster.

About battery sizes. When dealing with Lithium batteries it's often hard to gauge how much a battery will charge a gadget. If your phone has a 1600mAh battery, an external 1600mAh battery WILL NOT fully charge it. This is due to power conversions in your gadget and the boosting circuit in your charging source. The full truth of it is that to charge an iPhone you need at least a 2600mAh Lithium Battery. That should give you around 90-95% of a charge. Larger phones, and tablets, will get less of a charge. Smaller gadgets such as iPods and mp3 players will get several charges. Please keep this in mind when choosing a battery for your project.

In this setup I'm using a 3.7V 4400mAh battery. I also have done this with a 2600mAh battery and a 6600mAh battery. The battery you choose should be based on your needs and budget.

Solar Power

As a general rule when making a solar setup you'll want 1.5 times the voltage you really need. Sunlight is inconsistent, and if the sun's energy dips a bit, we want to be sure we have enough power to at least charge at a minimum level. Our battery needs a minimum 4.5V to charge, so ideally we'd want something around 6.5V to 7V in power (to play it safe). Unfortunately 7V solar cells are not overly common, so we have to stick with this common 6V solar cell. On the upside by using a 6V solar cell we're never going to over power the circuit (as it operates at 4.5V - 5.5V).

Another upside to this solar cell is that it has a high amperage. Amperage is what actually charges your battery. Think of it as the number of electrons going into your battery at any one time. The higher the amperage the faster your gadget charges (to a point). Most wall adaptors have an output of 1 Amp, or 1,000mA. Most gadgets can charge from as low as 500mA. Our solar cell has a max output of 830mA, which is a nice middle ground. It has enough power for direct solar charging or for a rather quick charge of the internal lithium battery.

If you're using a 2600mAh internal battery and have very good sunlight, it should take 3-4 hours to charge up the battery. I'm using a 4400mAh which means under very good conditions it'll take around 6 hours to fully charge it up.

If you were so inclined you could use two of these solar cells hooked together to get 1.6A, which would be the outer limit of what the Lithium Charge Controller can handle. This would also greatly decrease the time it takes to charge up the internal battery.

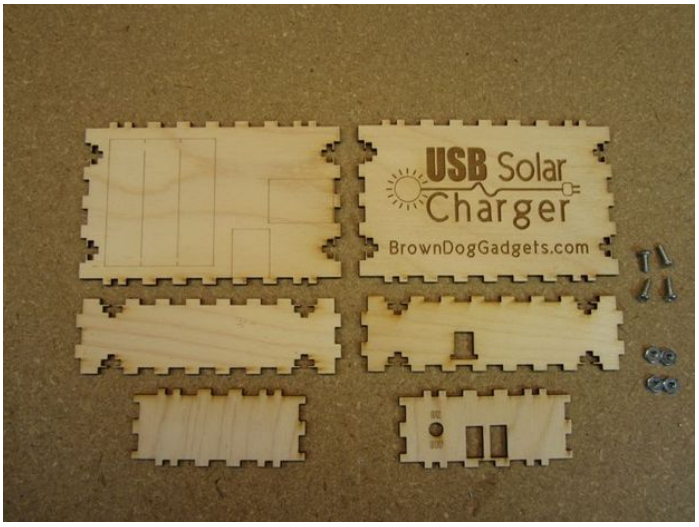
Step 4: Enclosures

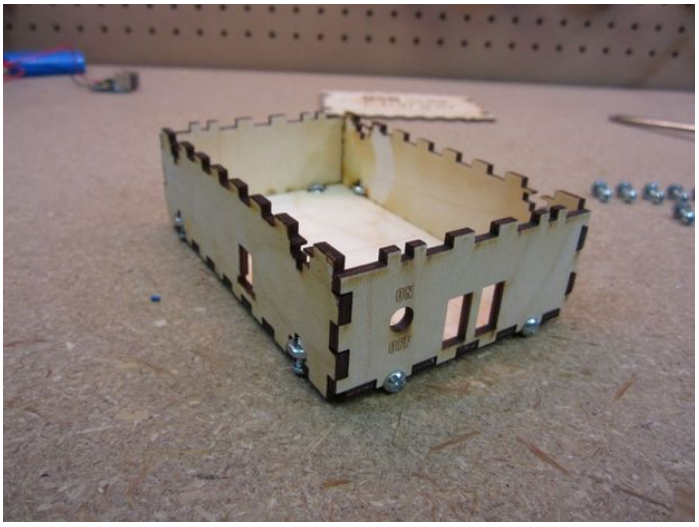
In this guide we'll be using a laser cut wooden enclosure. The wood is 1/8th inch Baltic Birch plywood, and a 12 inch x 12 inch sheet of this is usually under $2. I've included the laser cutting files if you have access to a cutter, and a single piece of wood should give you two boxes. If you're feeling really energetic you can always paint, stain, or varnish your laser cut wood.

The most simple way of making an enclosure is by using a plastic food container or plastic bin. They're easy to find and inexpensive. If you do grab a plastic food container try and find one with a rubber o-ring along the seal. This helps keep moisture out.

Most hobby websites have plastic or metal "project boxes". These also work, but can be expensive.

As a general rule I advise people not to use metal enclosures such as Altoids or Mint tins. These often short out and have really sharp edges. A plastic container is a much better solution.





File Downloads

Large USB Box MassProduce.ai (169 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'Large USB Box MassProduce.ai']

Step 5: Soldering the Solar Cell

First, grab your 2.5mm Barrel Jack Wire. Strip the ends of the wire about 1/4th inch. There are two wires as part of this system, the wire with the line printed on it is Positive, the one without a line is Negative.

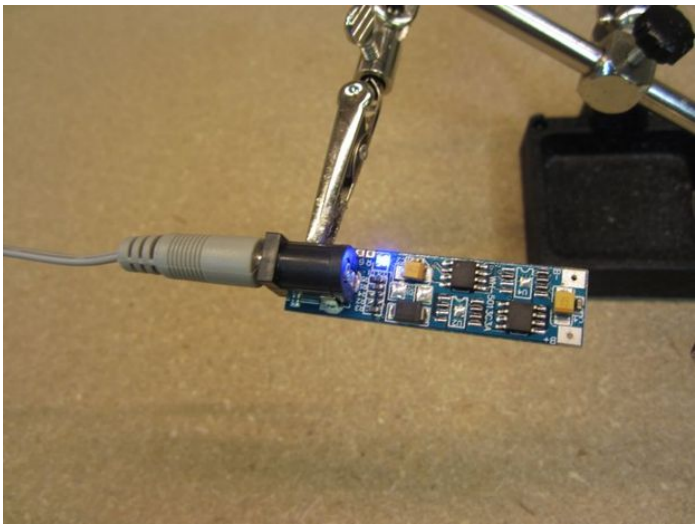
Second, test your wire out. Just to be safe. Plug the barrel jack into the Lithium Board. Now press the wires to the Positive and Negative terminals on the solar cell (when it's facing up and in some light). If the Lithium Charge Controller board lights up, your wires are fine. If not, try reversing them. (On the off chance the barrel jack and wires are weird or backward.)

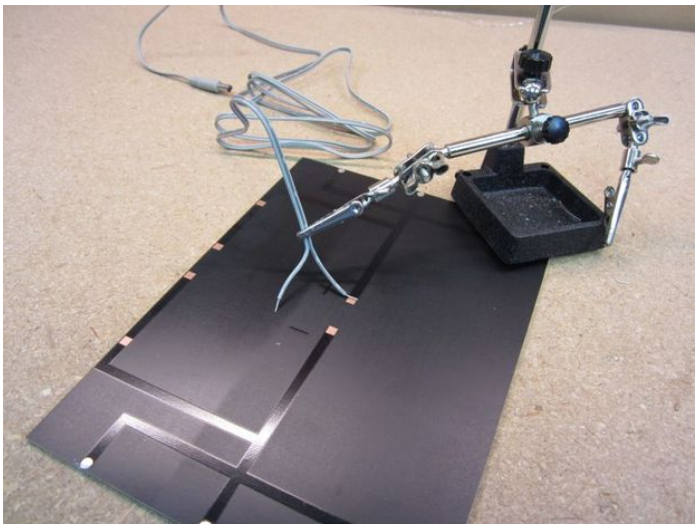
Third, solder the wires to the solar cell.

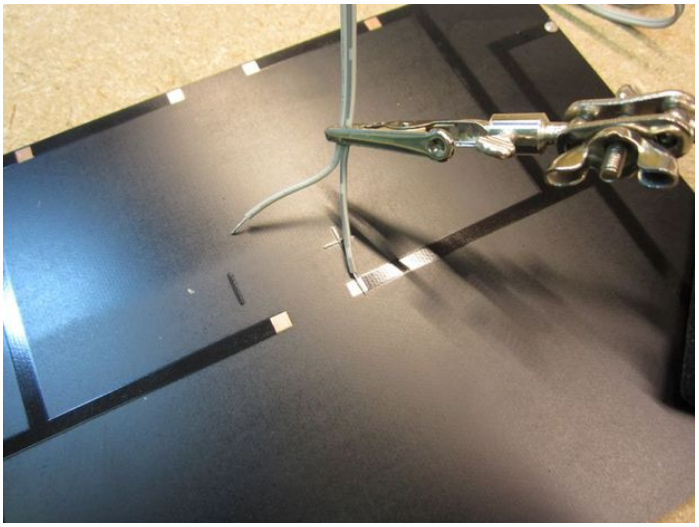
Forth, test it again. Just to be safe.

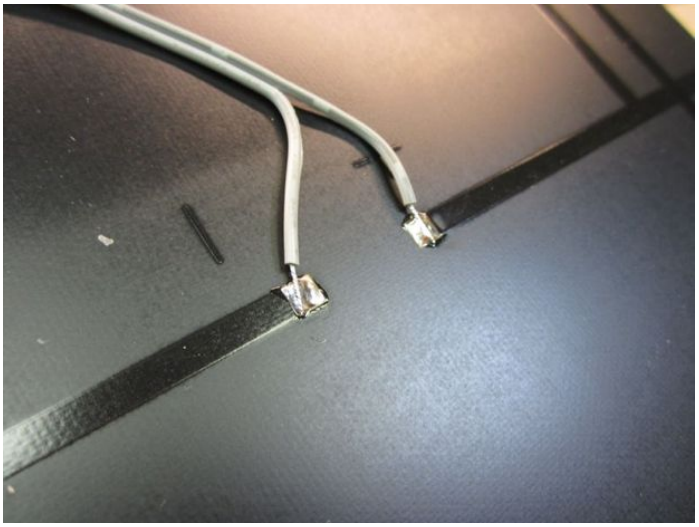
Last, use hot glue to secure it in place. Lift the wire up and put glue both below and on top of the wire. Use a strip of tape to hold it down while the glue dries.

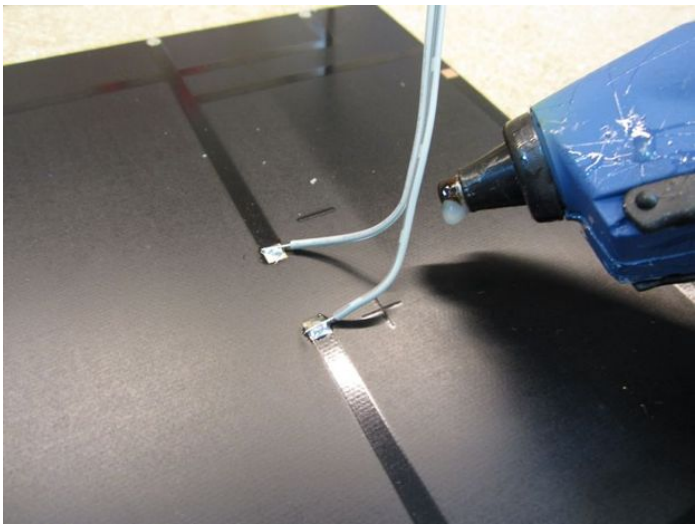
If you don't wish to use hot glue, silicon sealer also works well. The main point of this is to seal off the solder joints and also secure the cable in case it gets pulled on.

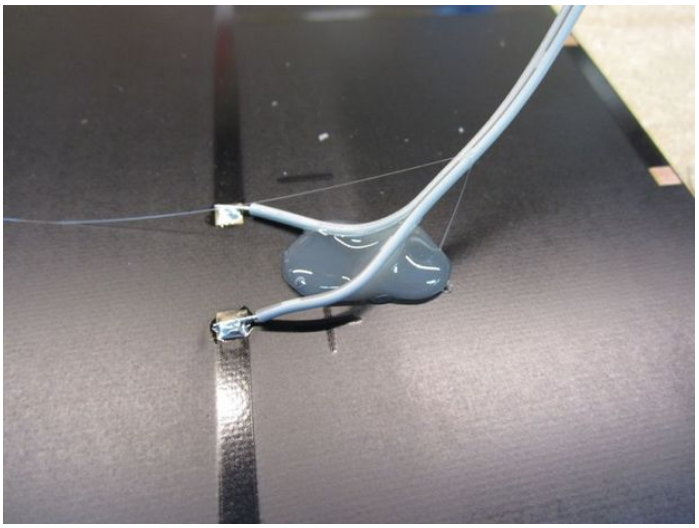












Step 6: Attaching the Charge Controller and Battery

When doing the next few steps be sure the bare wires between on the Lithium Battery don't touch. It'll make a big spark and could harm the battery. If you wish to play it super safe, always put a small piece of tape over one of the wires.

First, cut three lengths of wire about 6 inches in length.

Second, strip the ends of the three lengths of wire as well as the battery.

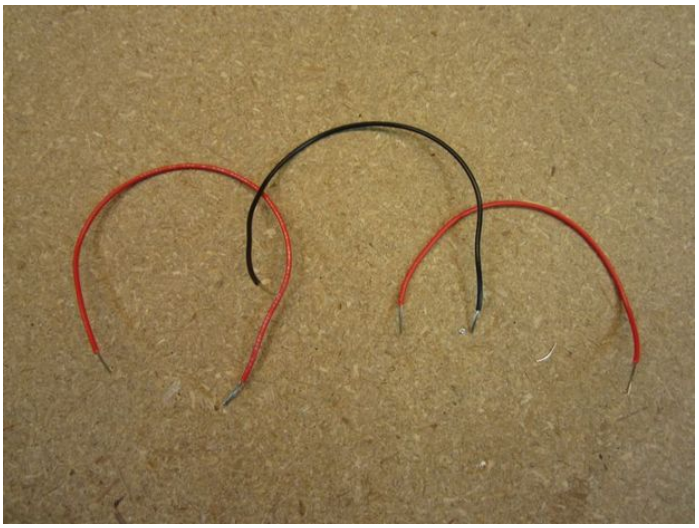
Third, take one of the lengths of wire and twist it with the Negative (black) wire from the battery. Do the same with a second length of wire and the Positive (red) wire coming off the battery. In the pictures above all positive wires are Red, and all Negative wires are Black.

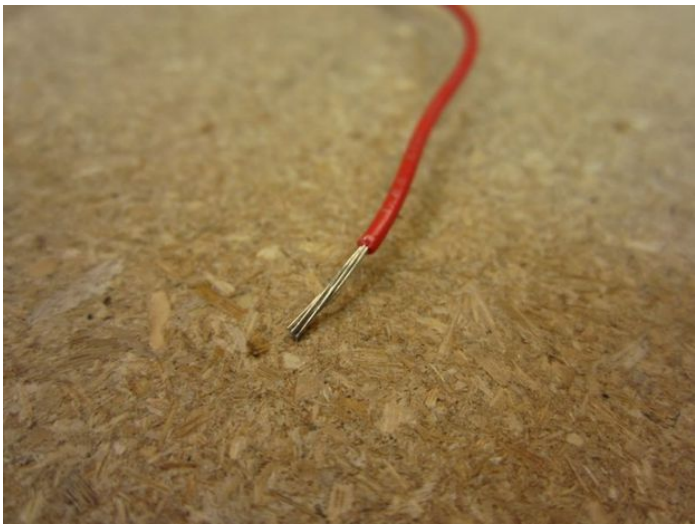
Fourth, thread the twisted end of the Negative wires (black in the pictures) through the Negative through hole on the Lithium Charge Controller. Go in from the top, and solder into place. You only need a small amount of solder.

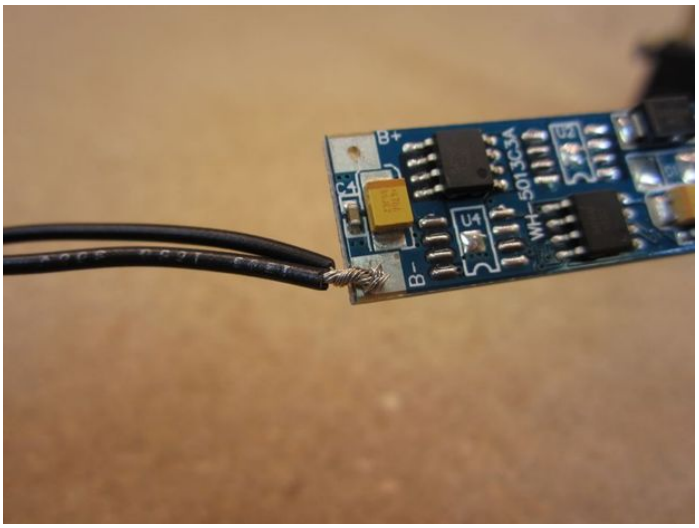
Fifth, do the same with the twisted together Positive (Red in the pictures above) wire. Come from the top, solder into place.

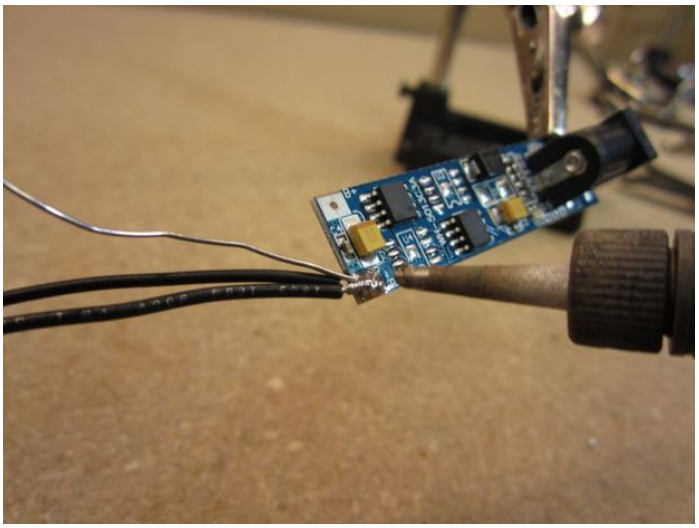
Lastly, cut off any extra bits of wire from the underside of the Charge Controller.

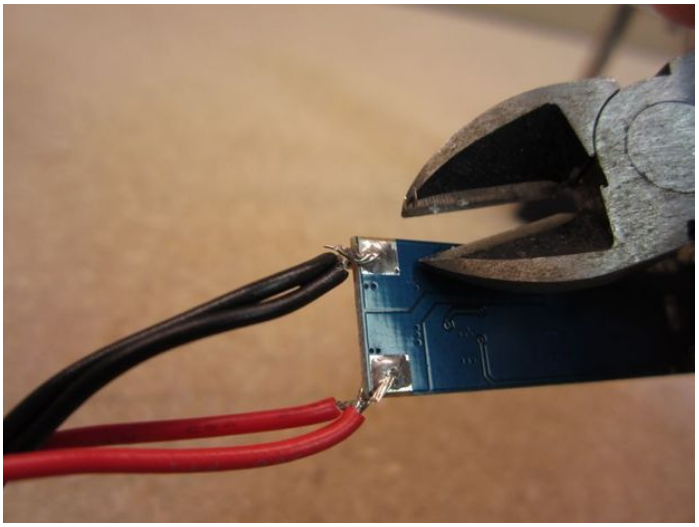
You now should have the battery connected to the Charge Controller, as well as have two lengths of wires coming off the charge controller.











Step 7: Attaching the Switch

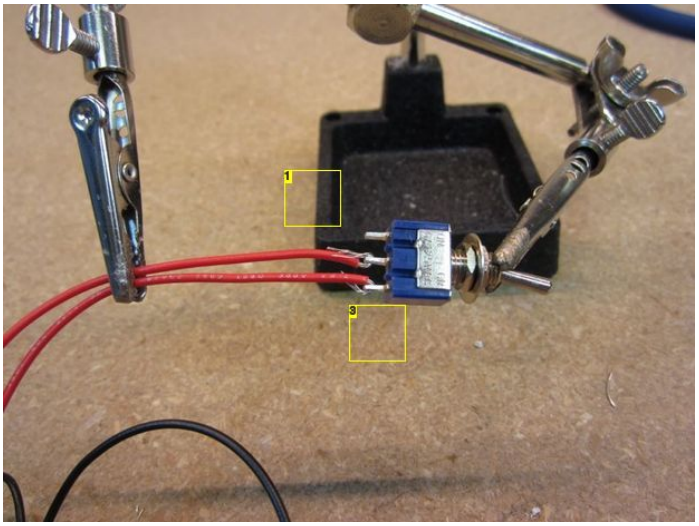
First, take the length Positive wire (red in the pictures) coming from the charge controller. Solder this to this to the middle pin of the toggle switch.

Second, take the remaining length of wire you cut (and have not used yet) and solder it to either outside pin. It doesn't matter which.

Lastly, cut any extra bits of wire that may be hanging off the switch.

Advice: It can sometimes be tough to thread the wire through the holes in the toggle switch. Use a Helping Hand to solder it to the side of the pin.

The switch can also easily be melted, as it is part plastic. Just be careful when soldering and don't keep it against the pins for more than five seconds.



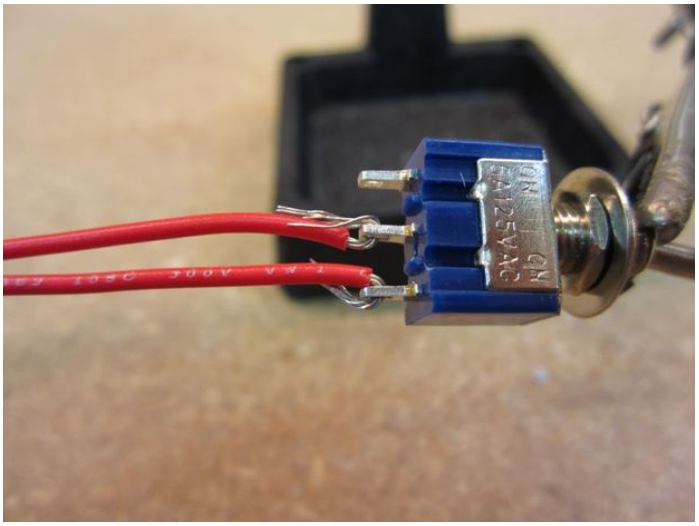
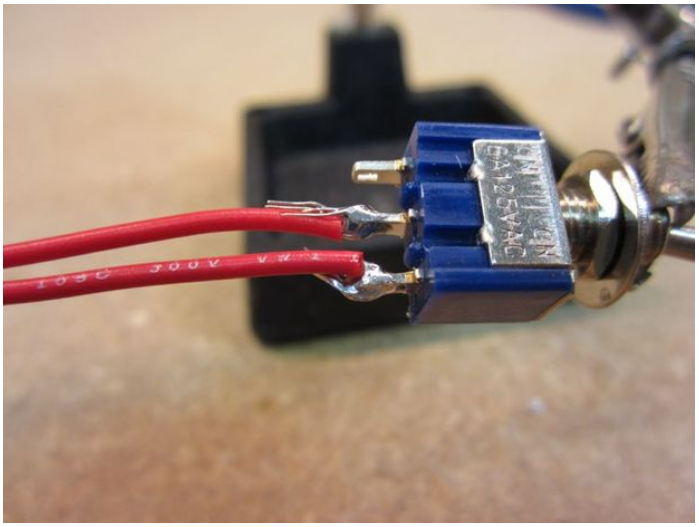


Image Notes
1. The middle pin should go to the charge controller.
2. The side pin will go to the USB Circuit
3. The side pin will go to the USB Circuit



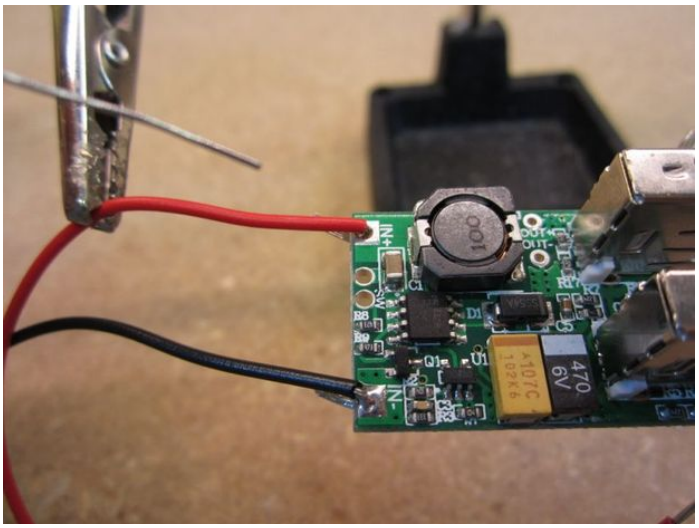
Step 8: Attaching the USB Circuit

At this point we should have a Positive wire freely hanging off the Toggle Switch and a Negative wire freely hanging off the Lithium Charge Controller. We just need to attach them to the USB Circuit.

Thread the wires through the through holes on the USB circuit. They're labeled IN + and IN -.

Solder into place.

You're now done.



Step 9: Testing and Troubleshooting

Before moving on it's best to test your circuit. Grab a small USB device and plug it in. If it doesn't turn on right away, try the toggle switch.

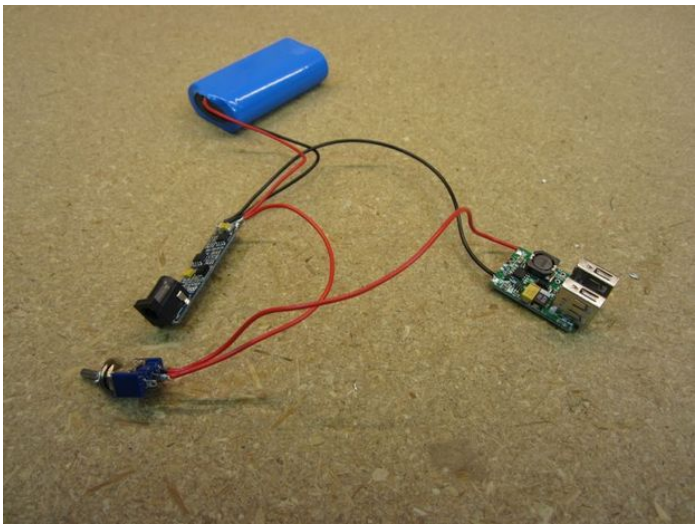
If things don't work.

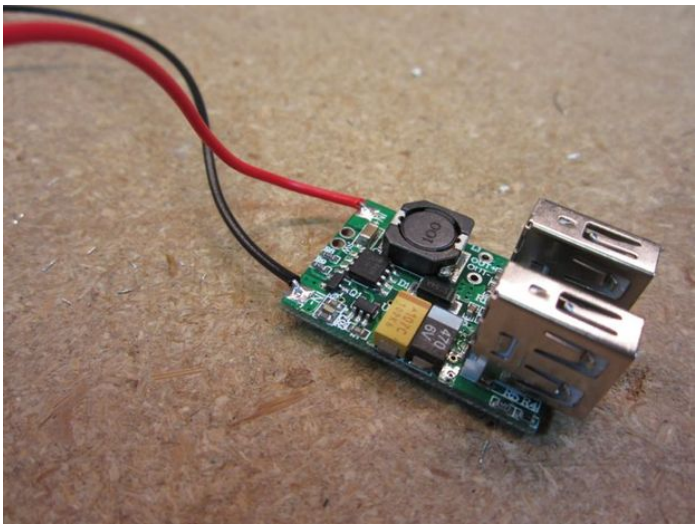
1) Both the USB Board and the Charge Controller Board have status LEDs on them that are good indications if things are working. If the LED on the USB Board is on, you know power is flowing to it. Same when you plug your solar cell in, you'll see either a Red "charging" LED or a blue "full" LED be lit.

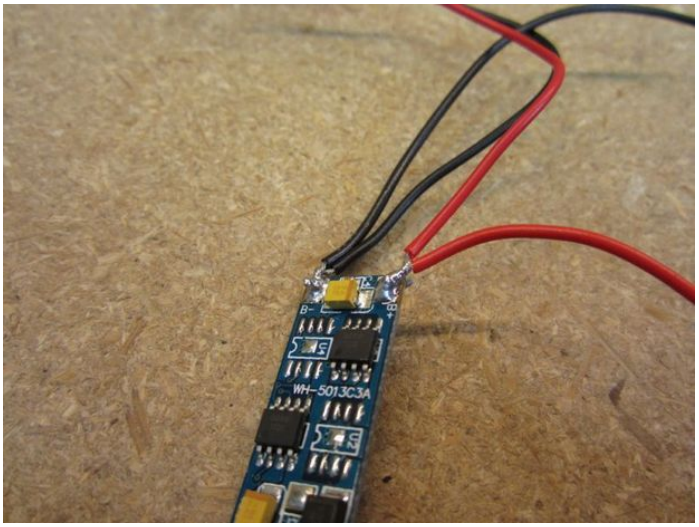
2) Is your battery dead? It's possible your battery is just dead or really low on power. Let it charge up in the sun for a day. If you have a 2.5mm wall adaptor (which is surprising common) plug it in. Just be sure it's rated at 5V DC and no more than 1 Amp of current.

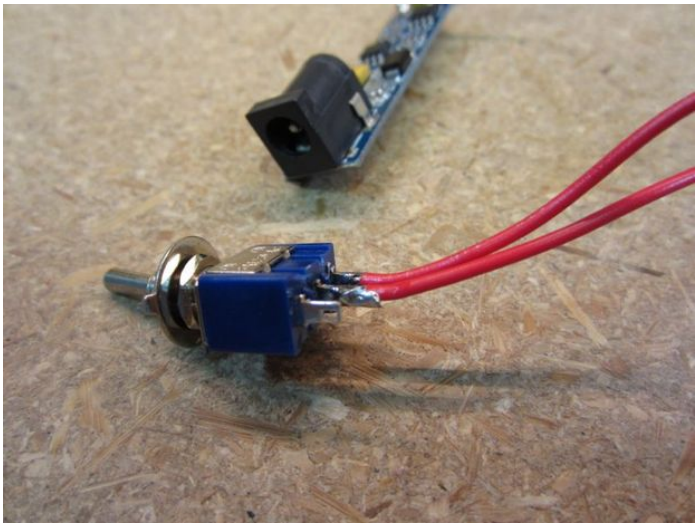
3) Is it your gadget? iPads might not charge off this board, but most other things will. Grab another device, even a keyboard, and see if it lights up or turns on.

4) If you're still having issues, grab a multimeter and make sure power is flowing everywhere. If your switch is broken, your battery will charge but the USB Circuit won't work. If the Charge Controller is bad you'll still get power flowing from the battery to the USB Circuit.









Step 10: Making the Box

If you're using my laser cut wooden box files or parts, follow this guide. Otherwise use a plastic food container or bin.

When putting the box together keep a couple things in mind. The screws tightly fit in and a little pressure is needed to pop them into place. While the wood is strong you can still break it. When pressing things together be sure to press from both the top and bottom. Lightly screw things into place first, and tighten it all up at the end. If you screw too tightly you can crush the wooden tabs, in which case you'll want to grab some wood glue to hold the box together.

First, count up your screws and nuts. You should have 16 of each. Lightly screw them together.

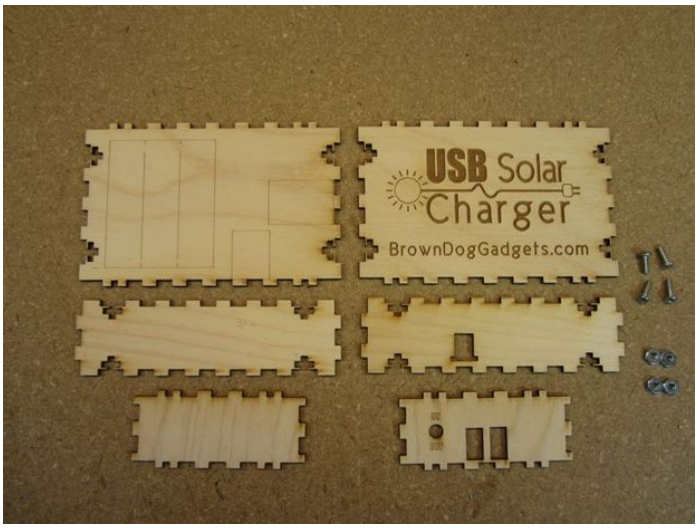
Second, start with the bottom of the box. Lightly screw all four sides into place.

Third, now is the time to place the electronics bits. Add foam tape to the bottom of your USB Circuit, Charge Controller, and Lithium Battery (a lot of the lithium battery). Put them in place on the bottom of the board along with the Toggle switch.

If you're having issues with the Charge Controller Board, try adding two strips of foam tape to the bottom of it to give it some height.

Fourth, put the top on and screw into place. If you don't like my logo, flip the top over.

Lastly, go around and tighten up the screws. Again, keep in mind that you can crush the tabs if you screw too tightly.


USB Solar
Charger
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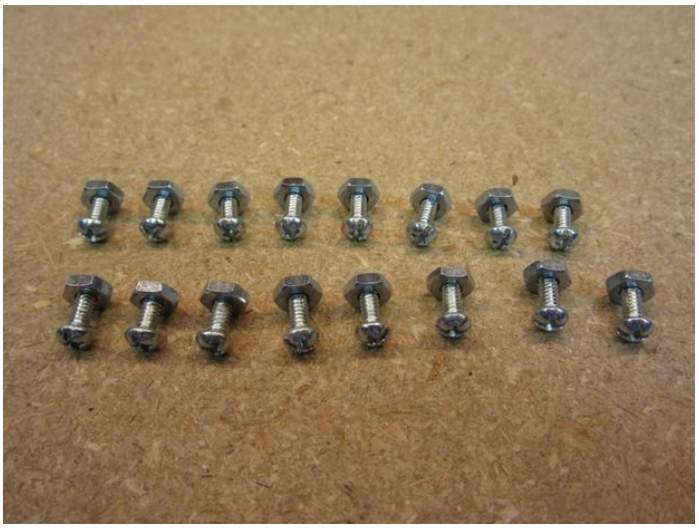
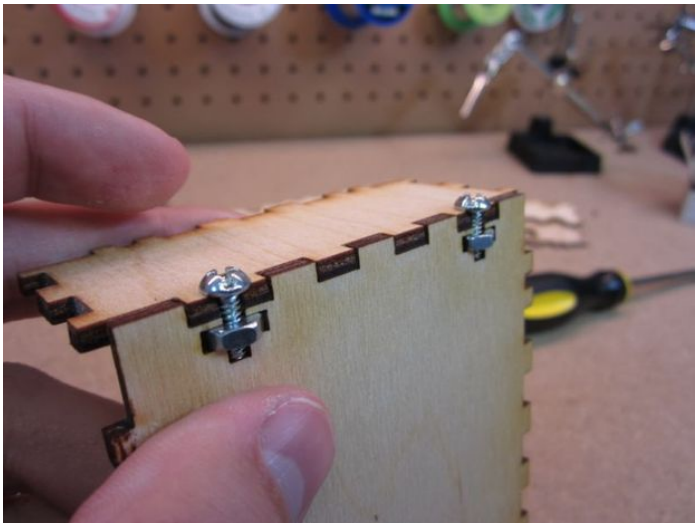
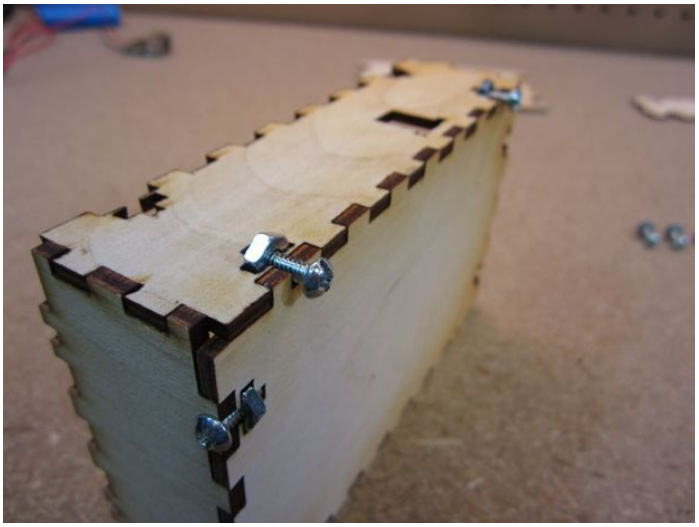
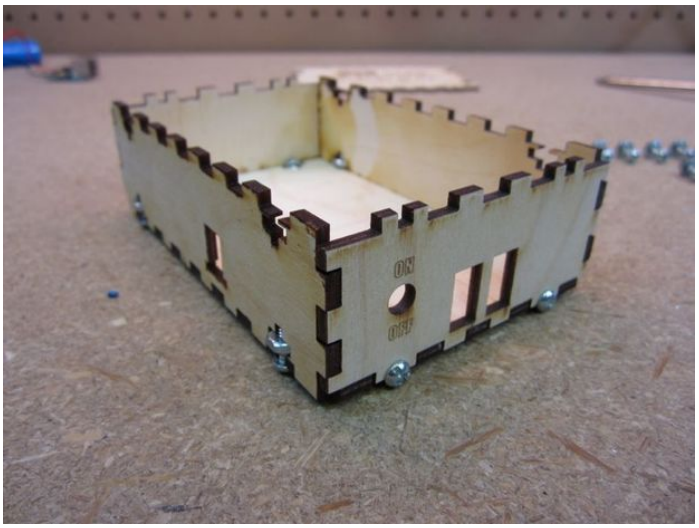
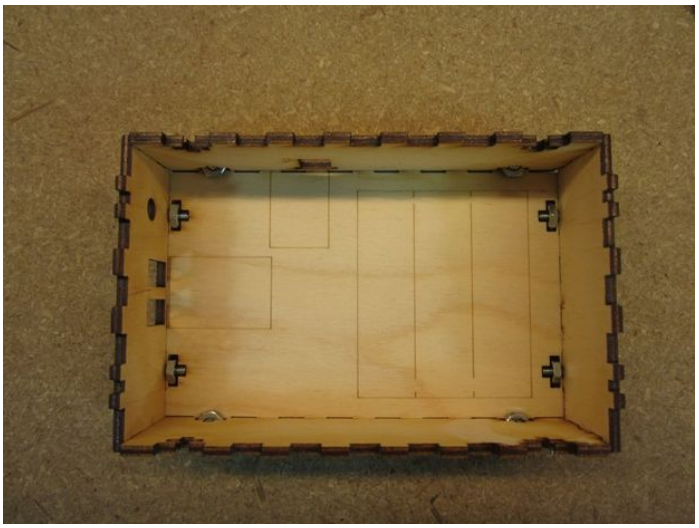
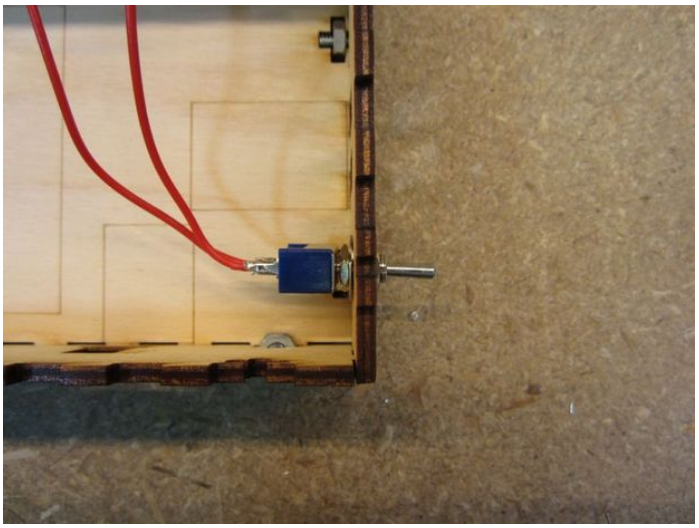


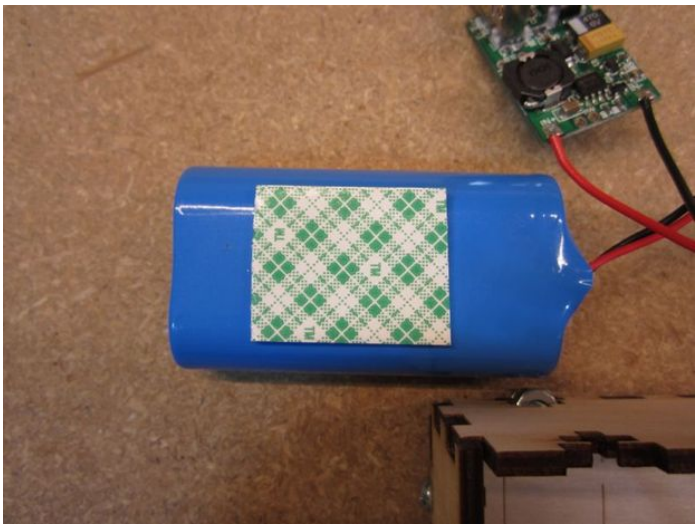


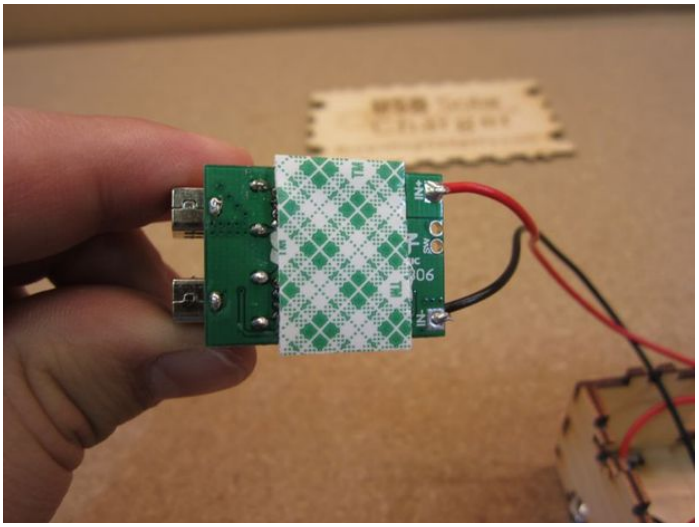


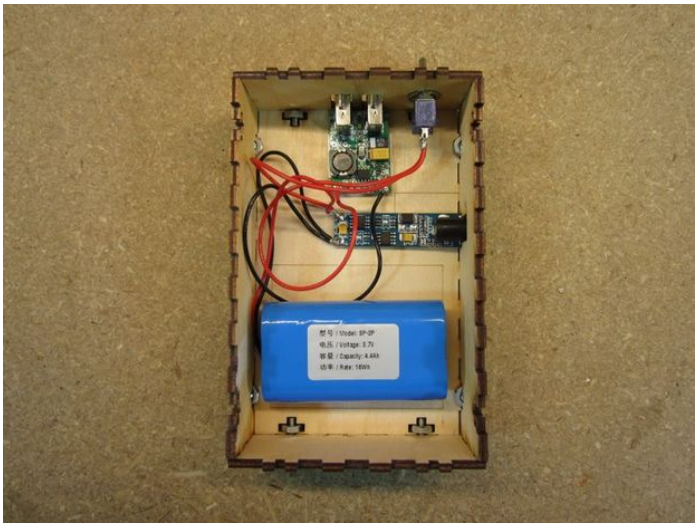


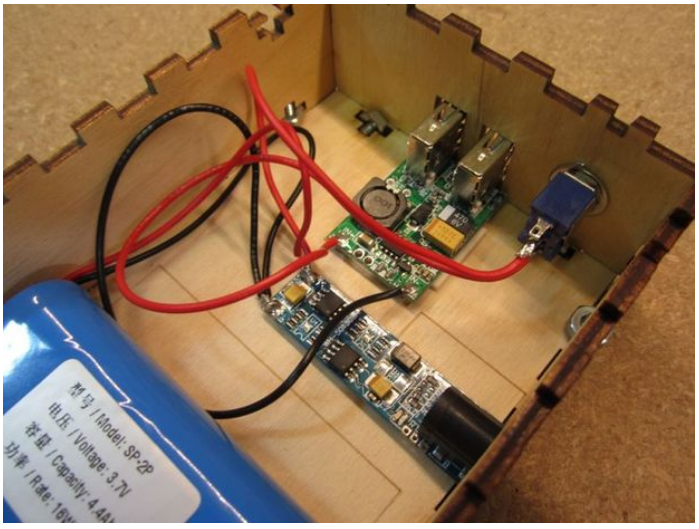


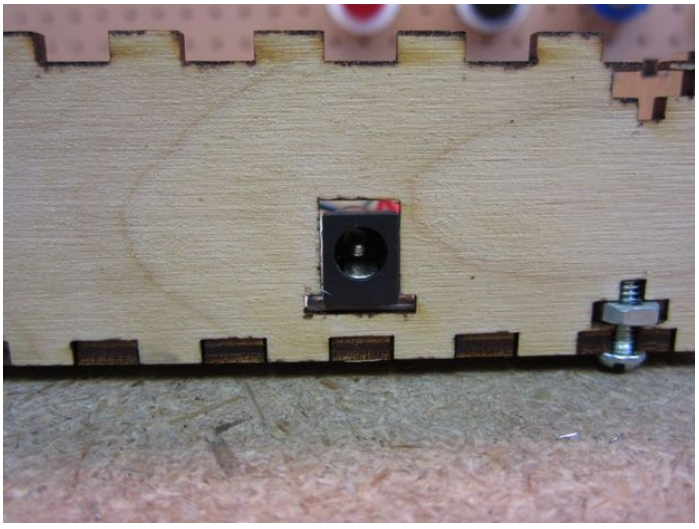


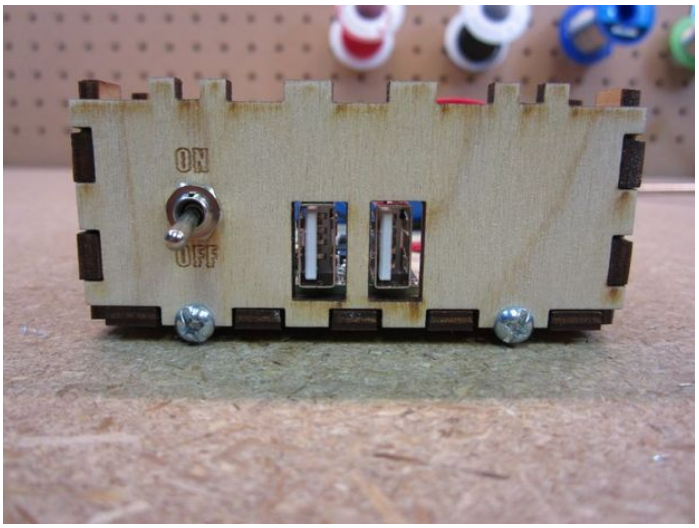


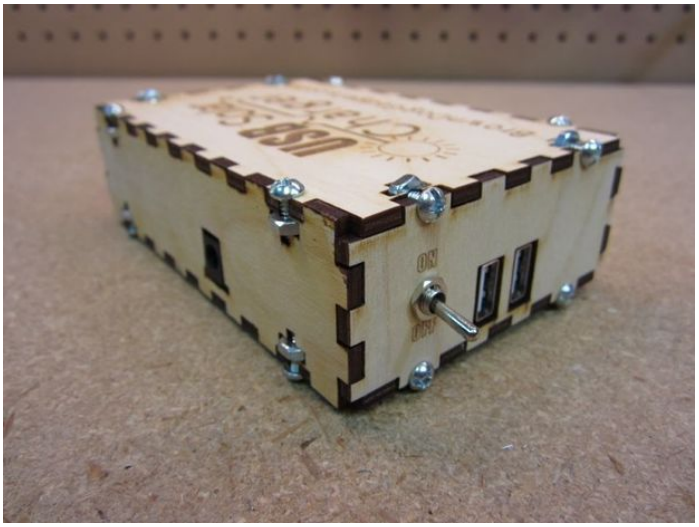












Step 11: The End

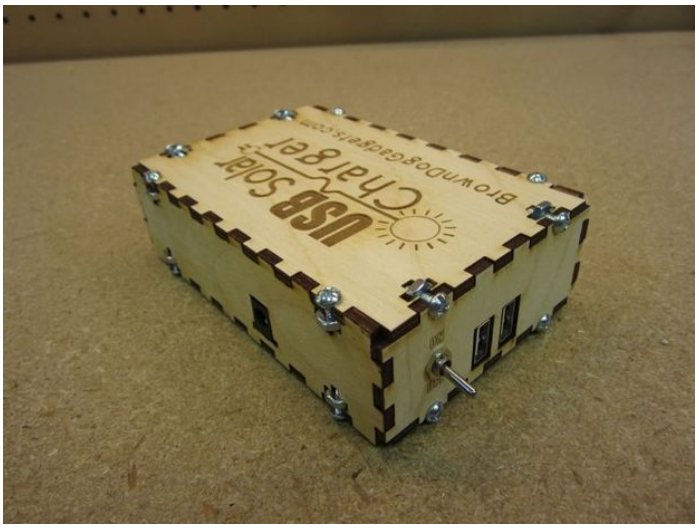
You should now be 100% done with this project and can start charging up gadgets left and right.

Notes on Operation: You can see the color of the Charge Controller LED through the barrel jack hole. It's not a great solution, but it works. You could laser cut out some clear plastic for the top if this bothers you. The USB Circuit has an LED thats always on. While this LED will take weeks and weeks to wear down the battery, thats why we have the toggle switch. If you ever felt the urge to, you could be all meta and use this charger to charge a charger, as seen in the photo above.

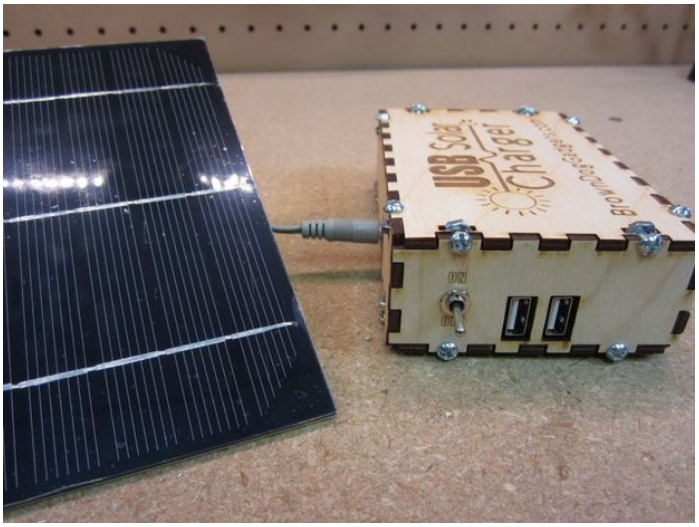
This charger is about as nice of a charger as you can make for yourself. It's more or less the same as most mid range commercial chargers in both parts and operation. The dual high amperage USB outputs make it a much better build than most DIY projects, which typically only output 500mA, and the large solar cell allows for direct charging as well as quick charging of the internal battery.

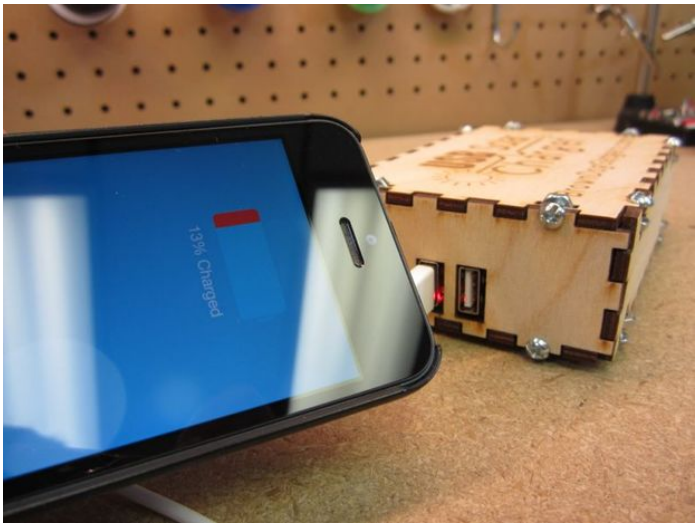
When it comes down to it, this is the kind of DIY project that you could take camping or keep in your window for daily charging of your gadgets. If you really wanted to beef it up, you could stick in a 6600mAh battery and use two solar cells for a 1.6A output, it just depends on your needs.

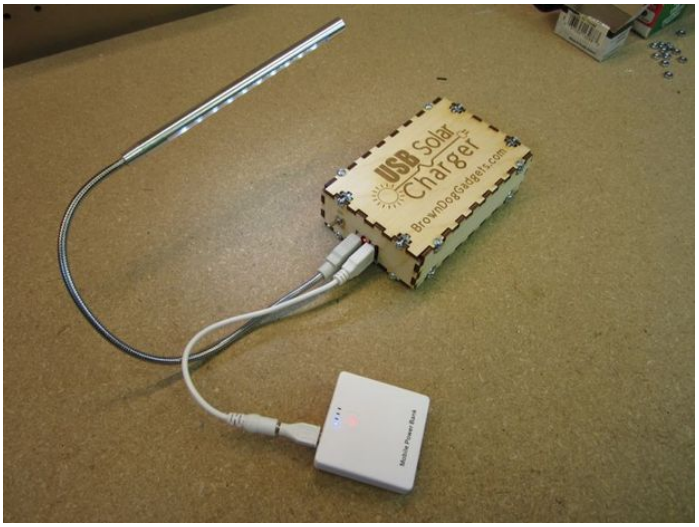
I have this kit available on my website and it comes with a laser cut wooden case. I also have a more basic Solar USB Charger 2.0 Kit if you're new to soldering or just need a simple science project. If you're someone who doesn't want to make a charger, but still want one, I've developed and manufactured several Folding USB Solar Cells. These are more or less what my hobbyist friends and customers were trying to make, but were doing a very poor job in doing so.

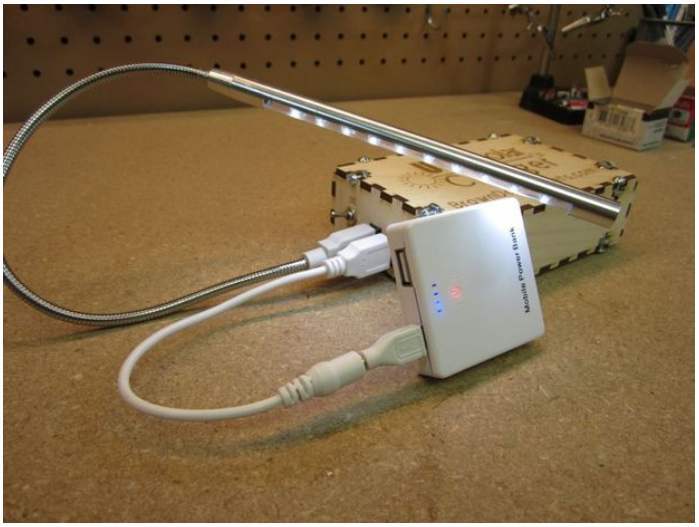

USB Solar Charger
BrownDogGadgets.com


USB Solar Charger


USB Solar Charger
ON


13% Charged


USB Solar Charger
BrownDogGadgets.com
Mobile Power Bank


Mobile Power Bank