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L M Wilkins

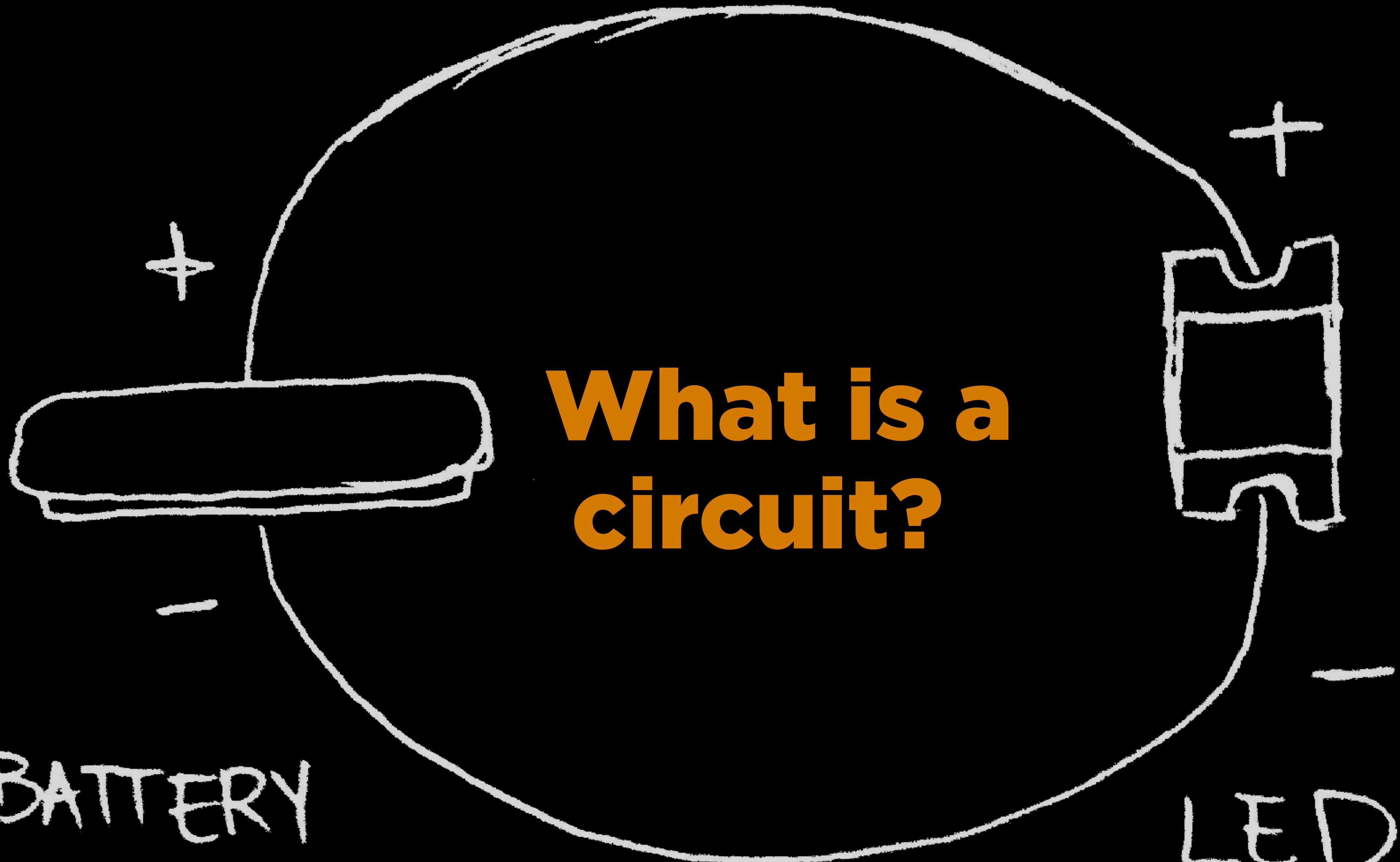
Solar Server

experimentation session 1

BATTERY

What is a
circuit?

LED



Circuit: A full connection between something using and something supplying power.

Lead: The (often wire) that connects parts of the circuit

Traces: When a lead is printed on a circuit board

Load: The part of the circuit using power

Insulator: A part of a wire that stops it from touching other parts of the circuit.

Short Circuit: When two parts of the circuit touch, allowing the power to skip the load

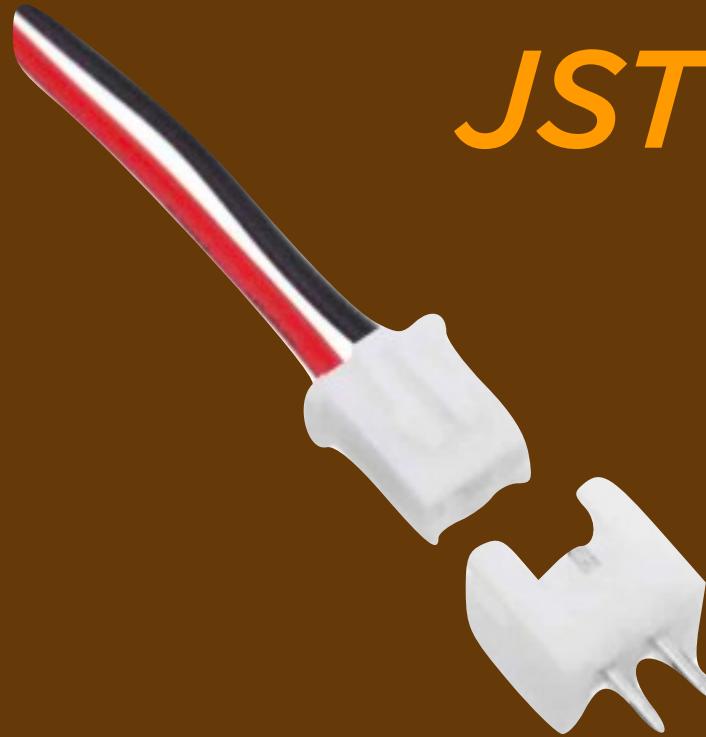
Energy: Total amount of work to be done

Power: How fast the work is being done

Controller: A board that controls the circuit

Terminology

Connectors



JST Connector



Barrel Connector

Jumper Wire / Dupont Cable



Alligator Clip

Voltage, V , Volts

Voltage, also called electromotive force, is the potential difference in charge between two points in an electrical field.

Resistance, r , Ohms

is the capacity of a material to resist or prevent the flow of current or, more specifically, the flow of electric charge within a circuit. The circuit element which does this perfectly is called the “Resistor”.

Amperage, I , Amps, Current

Current is the rate at which electric charge flows past a point in a circuit. In other words, current is the rate of flow of electric charge.

Any electrical thing you want to power will have a VOLTAGE and a CURRENT rating. Its important to know this information before you start to try and power it with a battery or a solar panel. You can sue resistance to modulate the flow of power. Resistance is (usually) a component called a resistor.



How does electricity work

All 3 have a beautiful relationship called Ohms Law, where you can use determine the current or voltage of a circuit by doing a simple calculation, and you can manipulate the flow of power by utilizing the proportional relationship of voltage and current but we don't need to think about that right now. Read more [here](#).

* there's lots to know about multimeters, here's a detailed explanation. This is just for reading solar cells.

Using a multimeter

Volts

Attach this to the + and - of your panel. Each option here is a range

If you don't see a reading, try changing the range (volts > Milivolts) and also check continuity to make sure your wire is actually connected! 20v measures up to 20v, 200v measures up to 200v, etc



Amps

Attach this to the + and - of your panel. Each option here is a range.

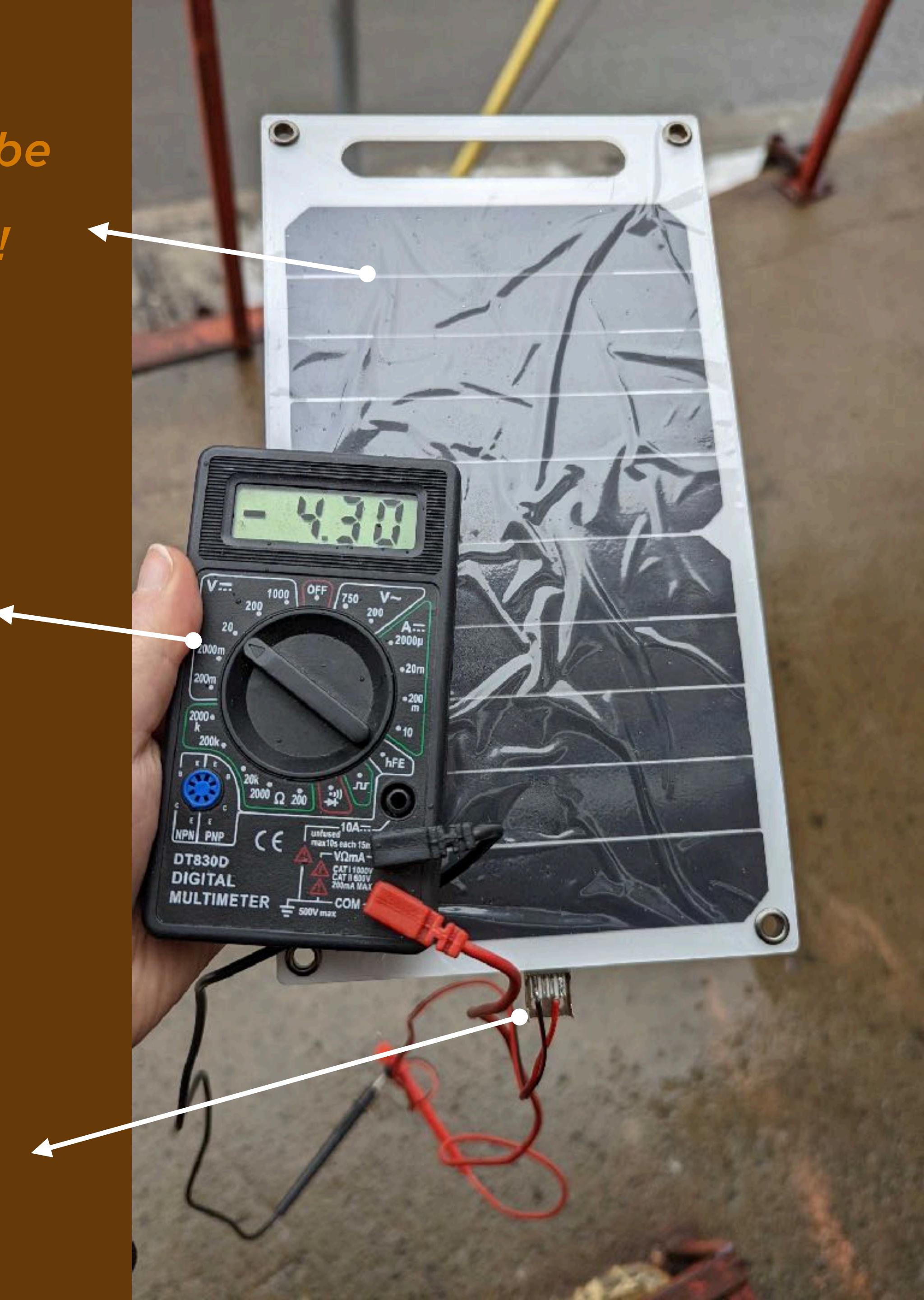
Continuity

You can use this to detect if your circuit is connected by putting the probes at the beginning and end of your connections and listen for the beep!

Solar panel should be facing the sun, you can move it around!

Turn to voltage or amperage, you may need to change the scale from V to mV

Connect to red and black



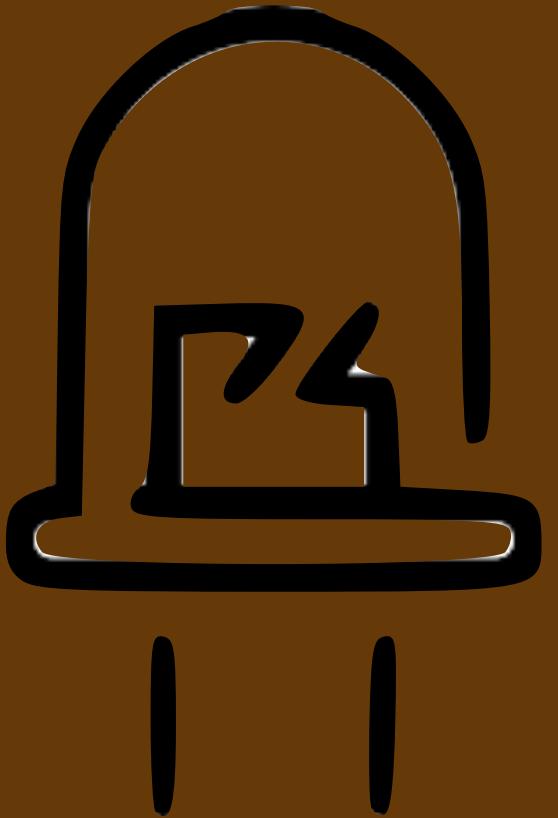
Battery Capacity (mAh)
—
Current draw (miliAmps)

= *Battery life(hours)*

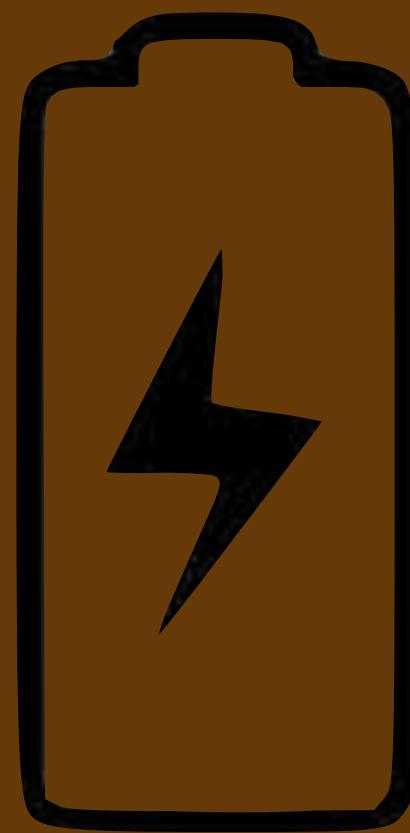


$$\frac{500}{20} = 25 \text{ Hours (at full brightness)}$$

Load



Battery



3v 20mA



Volts Mili Amps

Lets say this LED is the load of the circuit. Voltage is close enough, but might benefit from a resistor... Lets not worry for the sake of simplicity...

3.7v 500mAh



Volts Mili Amp Hours

Batteries are will have a voltage and an amp hour rating, amp hour represents the total capacity to spend depending on the circuit's draw

Calculating battery use

Wattage is the power produced or used per second. For example, a 60-watt light bulb uses 60 joules per second.

Wattage = Volts x Amps

$$W = V \times A$$

Watt hours Hours = Watts x Hours

$$Wh = W \times H$$

More info on calculating wattage needed for an off grid system [here](#).

Solar panel watts x average hours of sunlight x 75% = daily watt-hours

250 watts x 5 hours x .75 = 937.5 daily watt hours

Translate into KWh (like an electricity bill:

$$937.5 / 1000 = 0.937$$

0.94 kilowatt-hours per solar panel. Average household uses 20-30 kWh a day, I used 43 today :)

Wattage

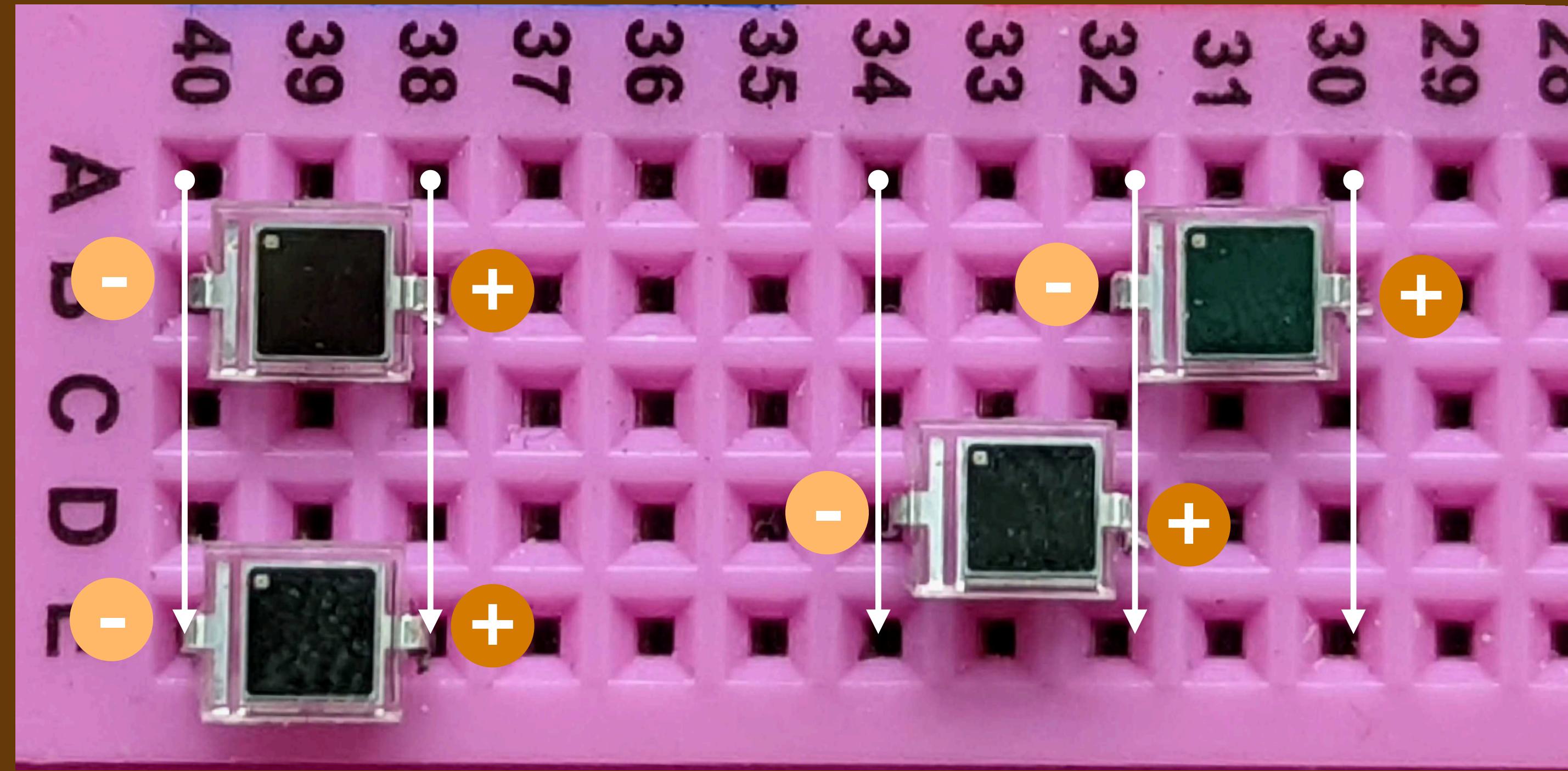
For most laptops, 2 solar panels with a capacity of 300 watts should be enough to charge your laptop. This has been calculated by keeping the power usage of the laptop in a range of 60 - 320 watts. To continuously run the laptop, you will need to select a battery with a high discharge capacity and faster charging. Since the solar panels can only work during the daytime, your battery must have sufficient power to power your computer for at least 7 hours at a stretch. More [here](#).

Laptop power



* Full explanation on how this relates to solar panels and how to choose the right configuration here.

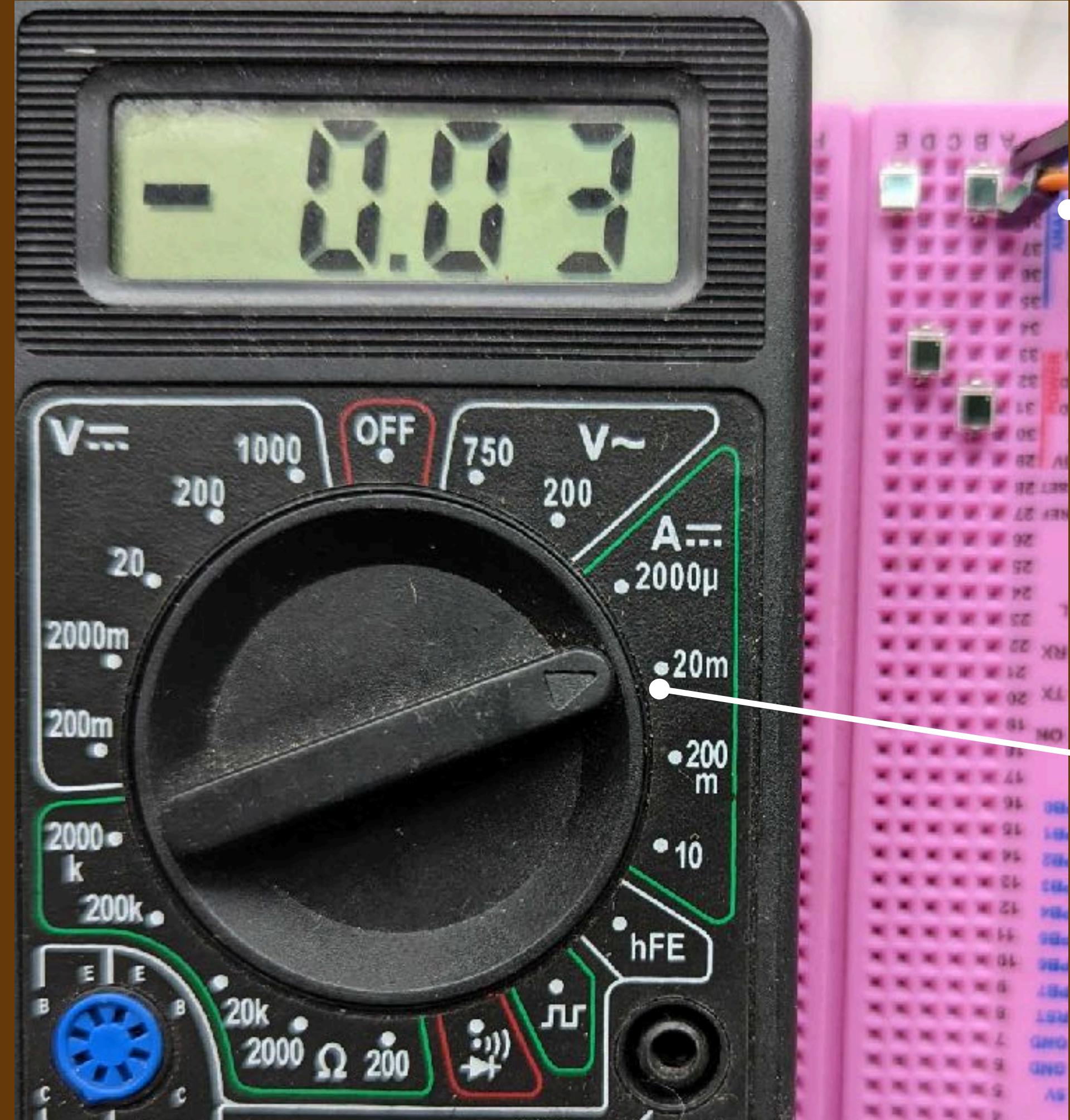
** Full explanation on breadboards here.



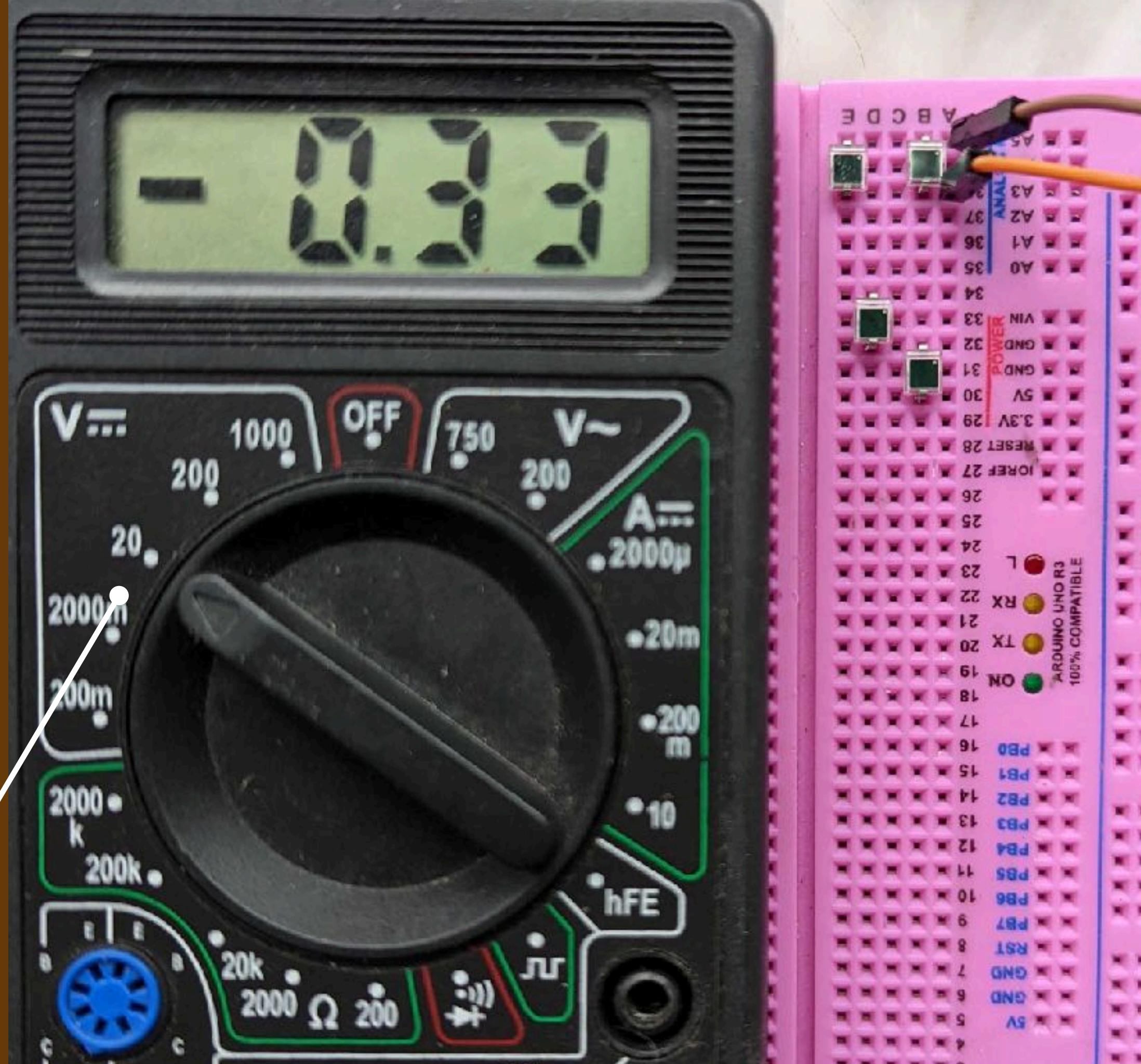
Parallel: All the + and - are connected causes Amperage to increase, and voltage to remain the same

Series: + connected to -, connected to +, connected to -, causes Voltage to increase, and Amperage to remain the same

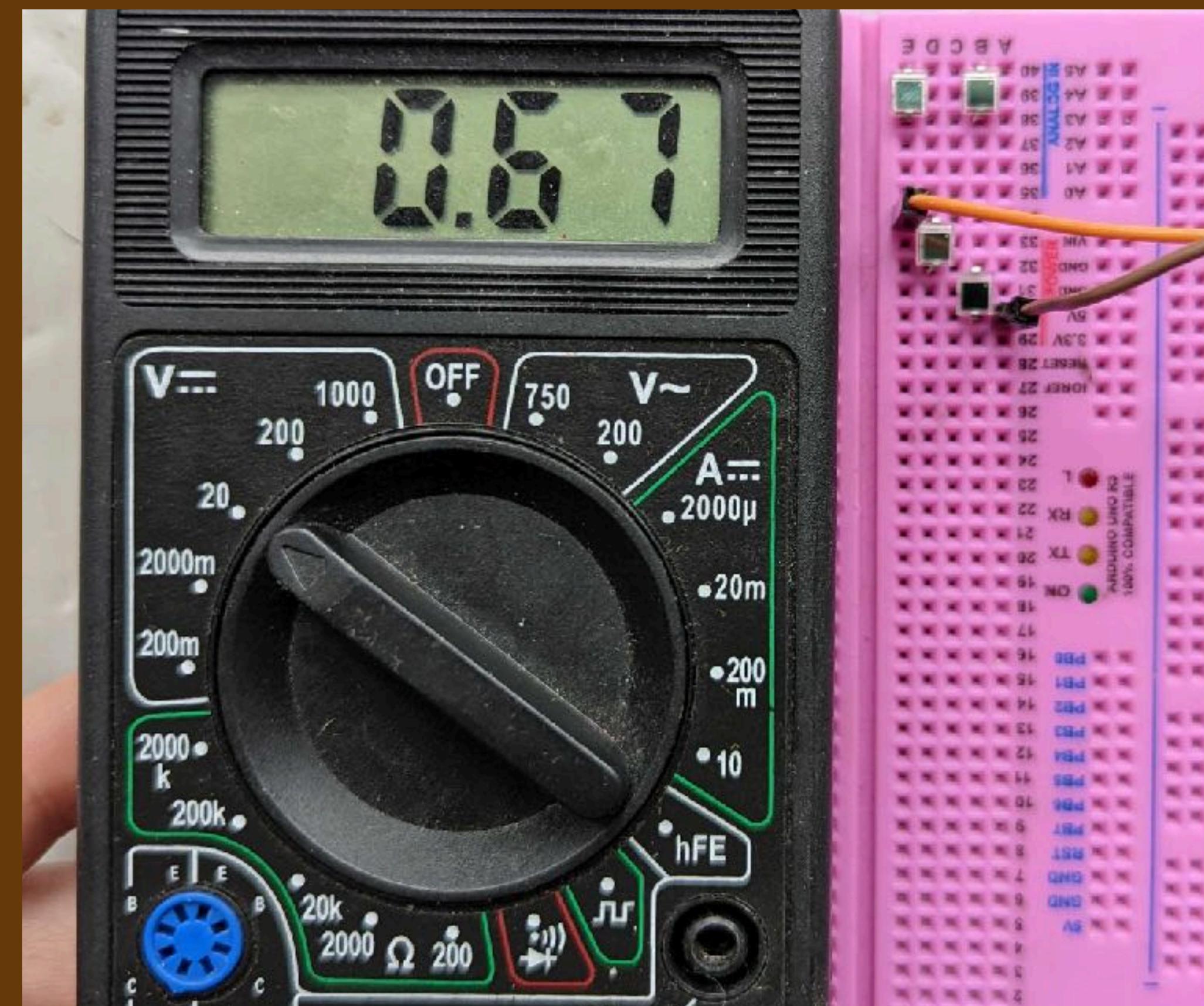
Cells in series or parallel



Wired in parallel on the breadboard, jumper wires are connected to the + and -



Cells in series or parallel



Cells in series or parallel



Microamps parallel



Volts parallel



Microamps Series



Volts Series

Cells in series or parallel



A 100 watt solar panel generates 5.5 amps an hour.

Divide the solar panel voltage by its wattage and you can determine how many battery amps per hour the solar panel produces.

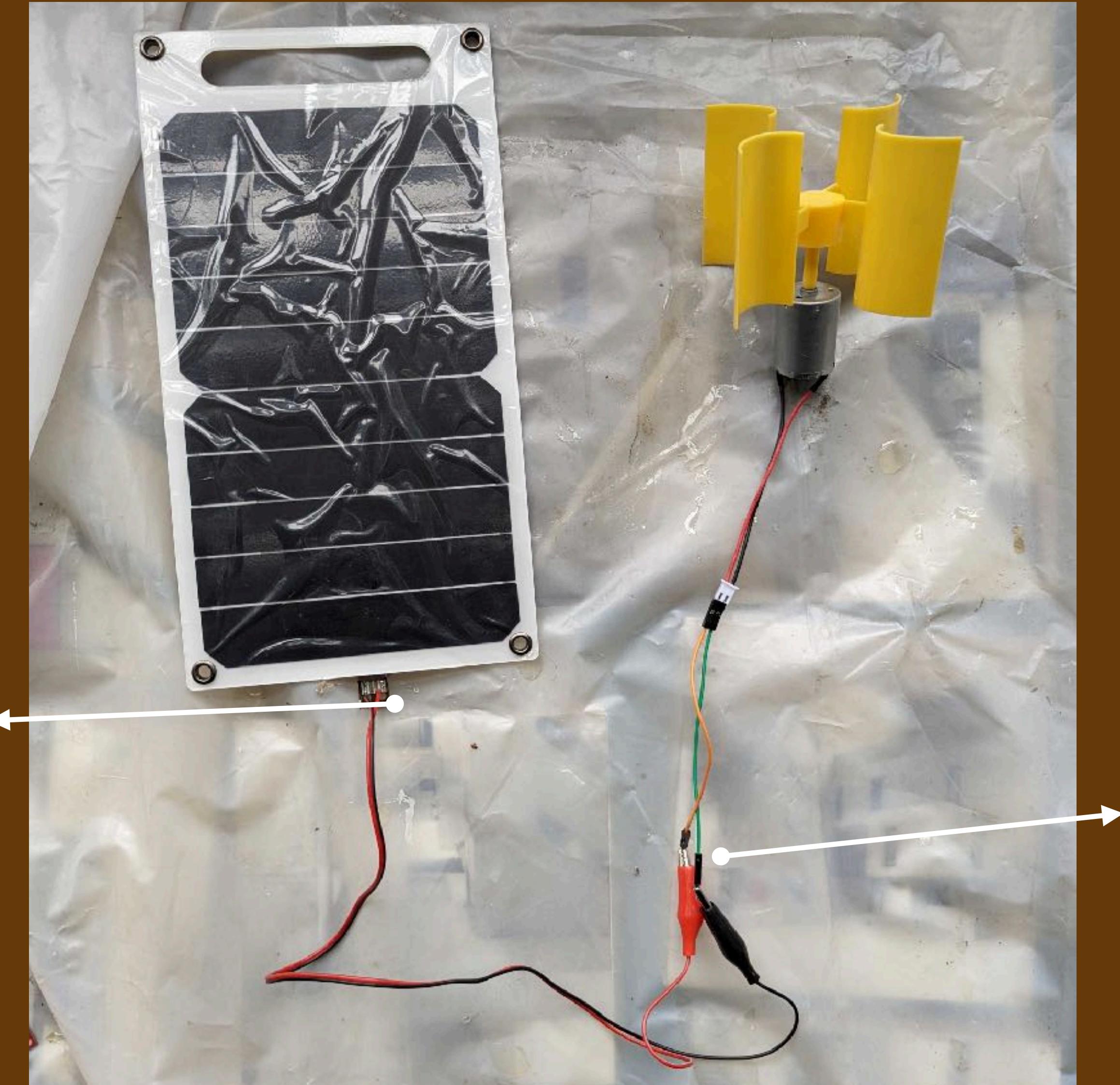
$$W/V = A$$
$$100 / 18 = 5.5 \text{ amps}$$

$$\text{Amps} * \text{Hours} = \text{Amp hours}$$
$$5.5 * 10 = 50 \text{ aH}$$

Ultimately the solar circuit doesn't power the load. Instead, you charge a battery and the battery output provides the power. This ensures that the power is stable, prolonging the life of our electronics!

Controllers & Charging

Direct solar power



**This is fine for simple components but won't work for computers or that is doing computation. Always check the voltage ratings and outputs*

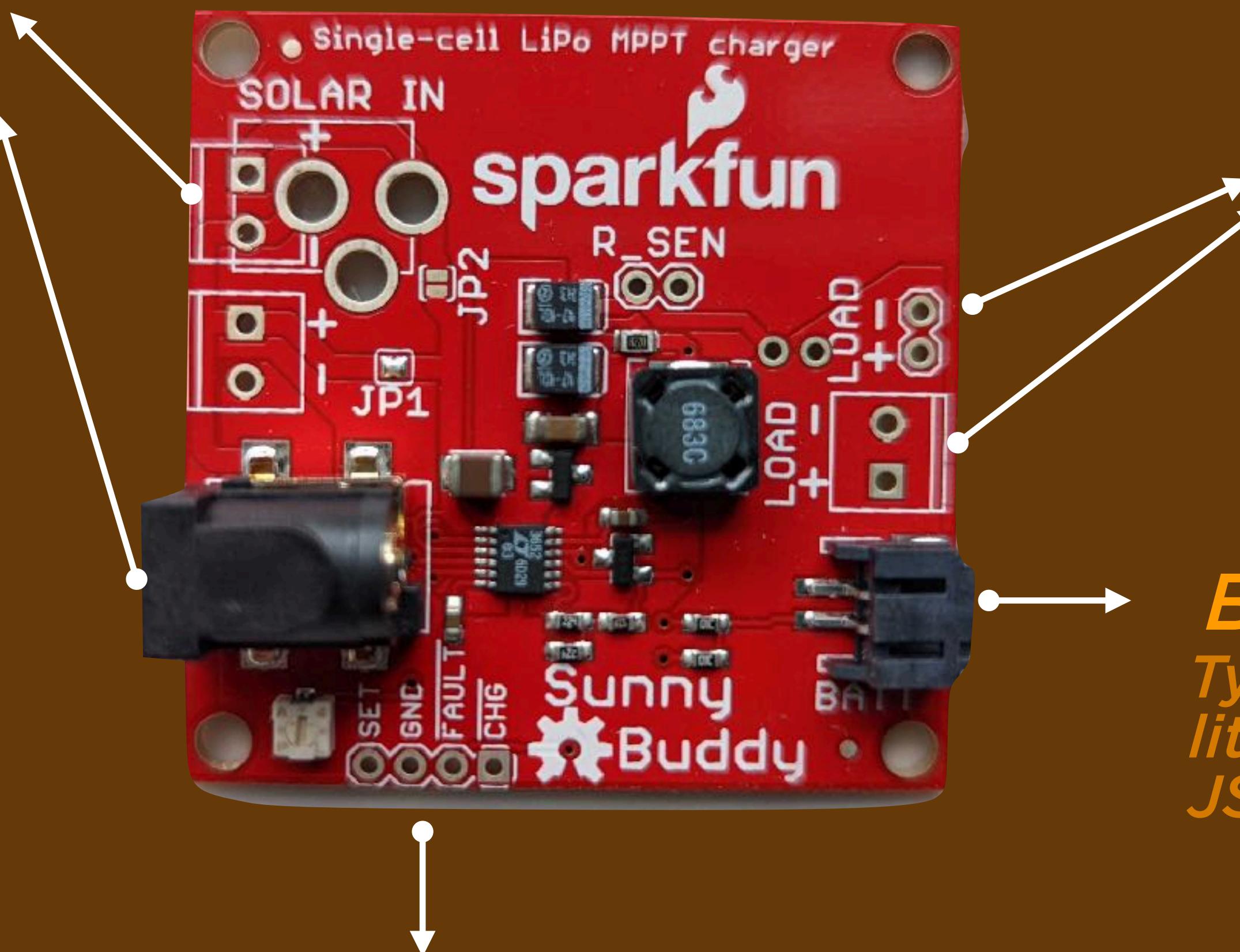
Load /

Thing to power

Connect the + and - of anything!

Solar panel input

You can connect the + and - with a clip or barrel



Battery

Typically a rechargeable lithium battery with a JST connector

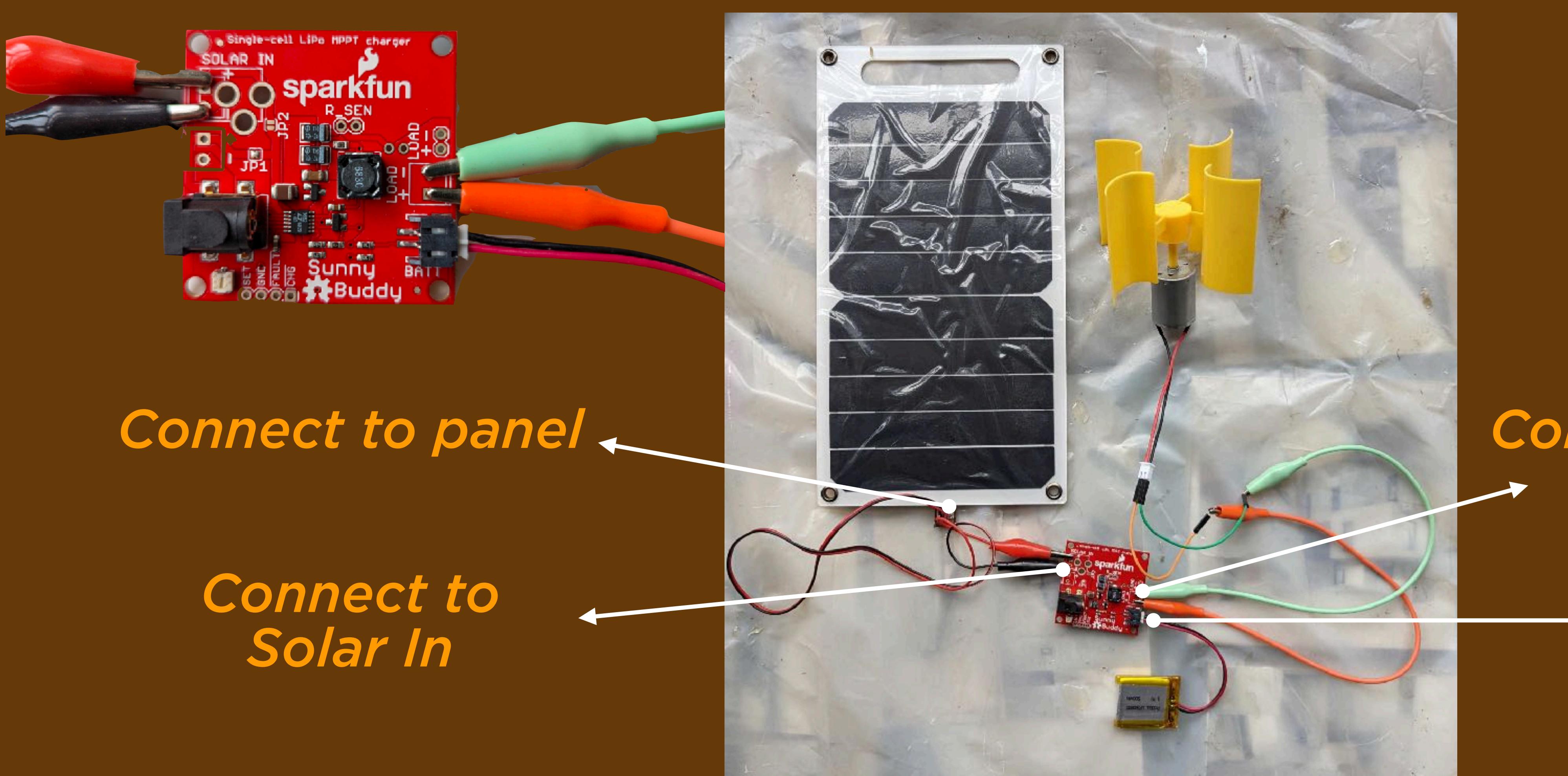
Data / monitoring

This can be connected to a micro controller

* Full explanation on the [Sunny Buddy here](#)

** You can use multiple points to solder different types of connectors to the board

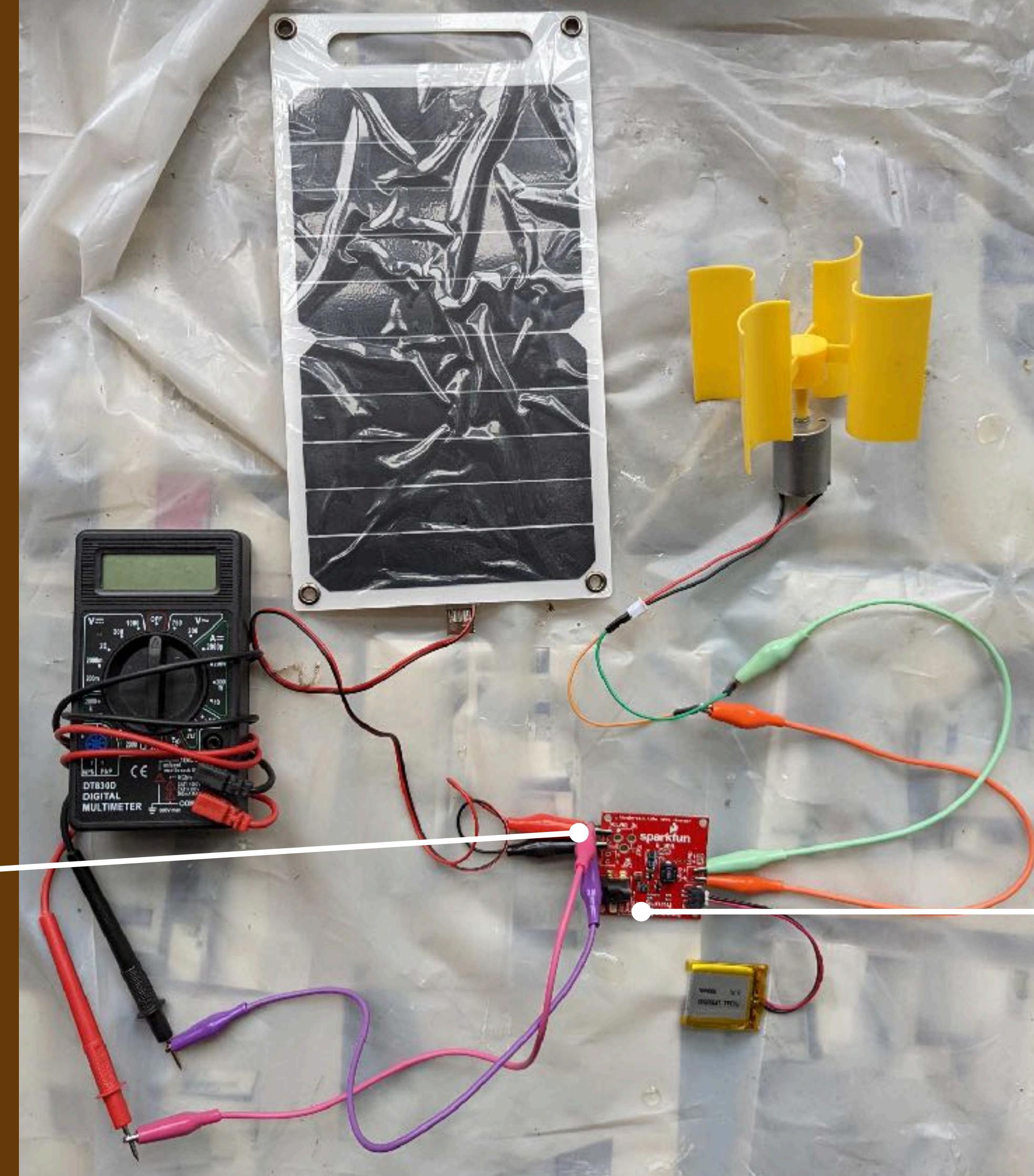
Solar charging circuit



Using a basic controller

Direct solar power

You can
connect here
to measure
the output
with the
multimeter



You can
connect here
to measure
the output
with an
Arduino



*You can cut a
USB cable and
make these
hand plug and
socket USBs
with alligator
clips to
connect
anything to
solar panels*



