IMCA 222
Electronics for Artists
Fall 2025

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Class is on Zoom even in the classroom for sharing, find the details on Moodle https://moodle.concordia.ca/

Download the slides!

PAY YOUR FEES please

1. Log into the Student Hub OR (https://adsys2.concordia.ca/OFAF/pages/ Default)

HYBRID LAB SCHEDULE

FALL SEMESTER

TIME	MON	TUE	WED	THU	FRI
8:30		**IMCA 221** 08:30 12:30		**IMCA 222** 08:30 12:30	
9:00					
9:30					
10:00					
10:30	**OPEN LAB*** 10:30-13:00		**OPEN LAB*** 10:30-13:00		
11:00					
11:30					
12:00					
12:30					
13:00		**OPEN LAB*** 13:00-16:30		**OPEN LAB*** 13:00-16:30	
13:30	**IMCA 220** 13:30-17:30		**IMCA 321** 13:30-17:30		
14:00					
14:30					
15:00					
15:30					
16:00					
16:30					
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Beautiful Circuit Assignment

Due September 18, 15%

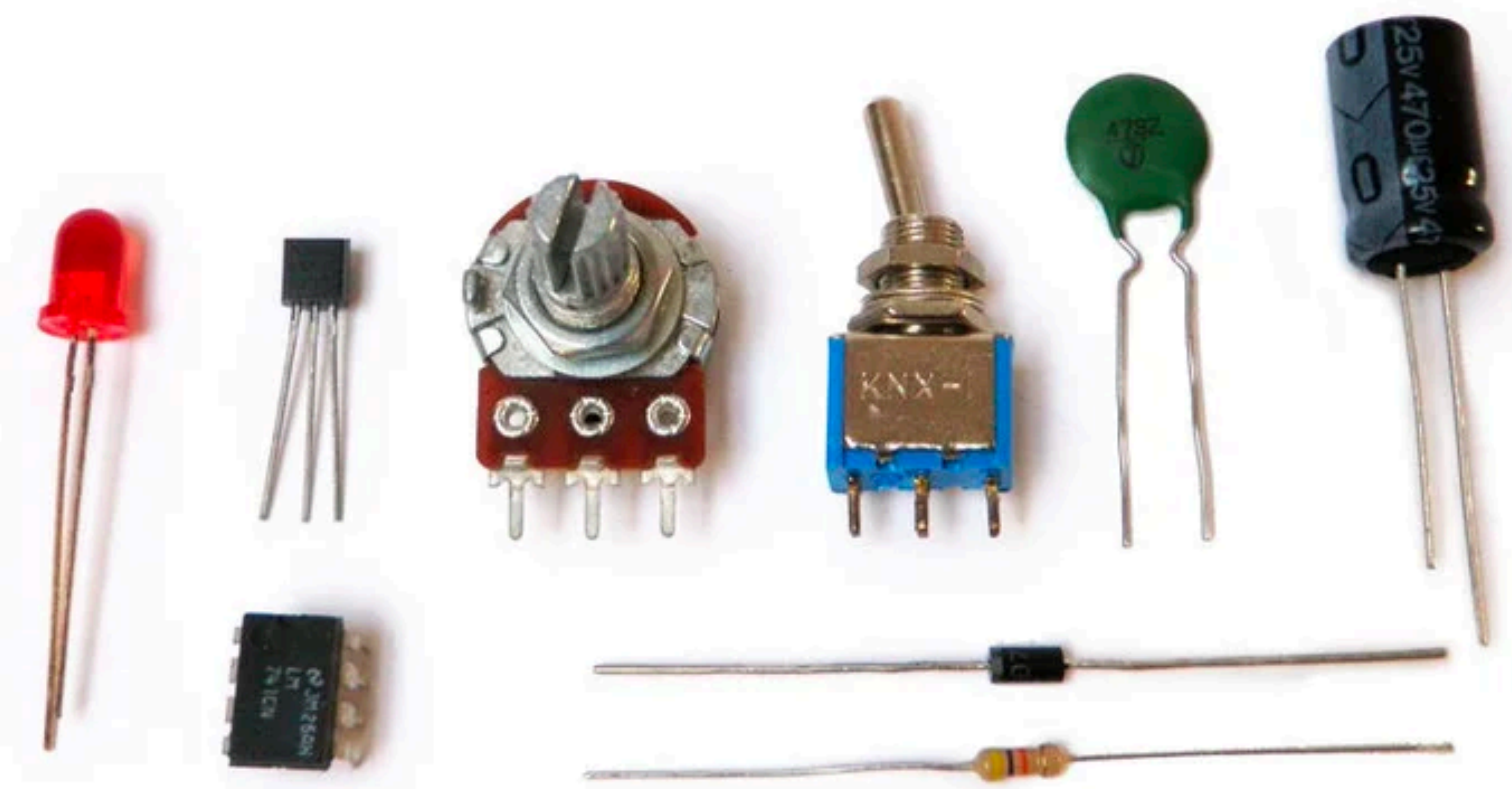
Create a functional circuit using nontraditional conductive materials (copper tape, conductive thread, aluminum foil, anything else you find etc) where the circuit is incorporated into the aesthetic design o the object. You can use LEDs, motors or buzzers, but the circuit must be visible, with attention paid to the layout and craftsmanship. You should move through at least two (possibly more) iterations of this circuit. Be sure to carefully document your process and design choices, taking photos along the way. Bring the final prototype to class and post your project documentation to the Moodle.

Documentation should include a PDF with:

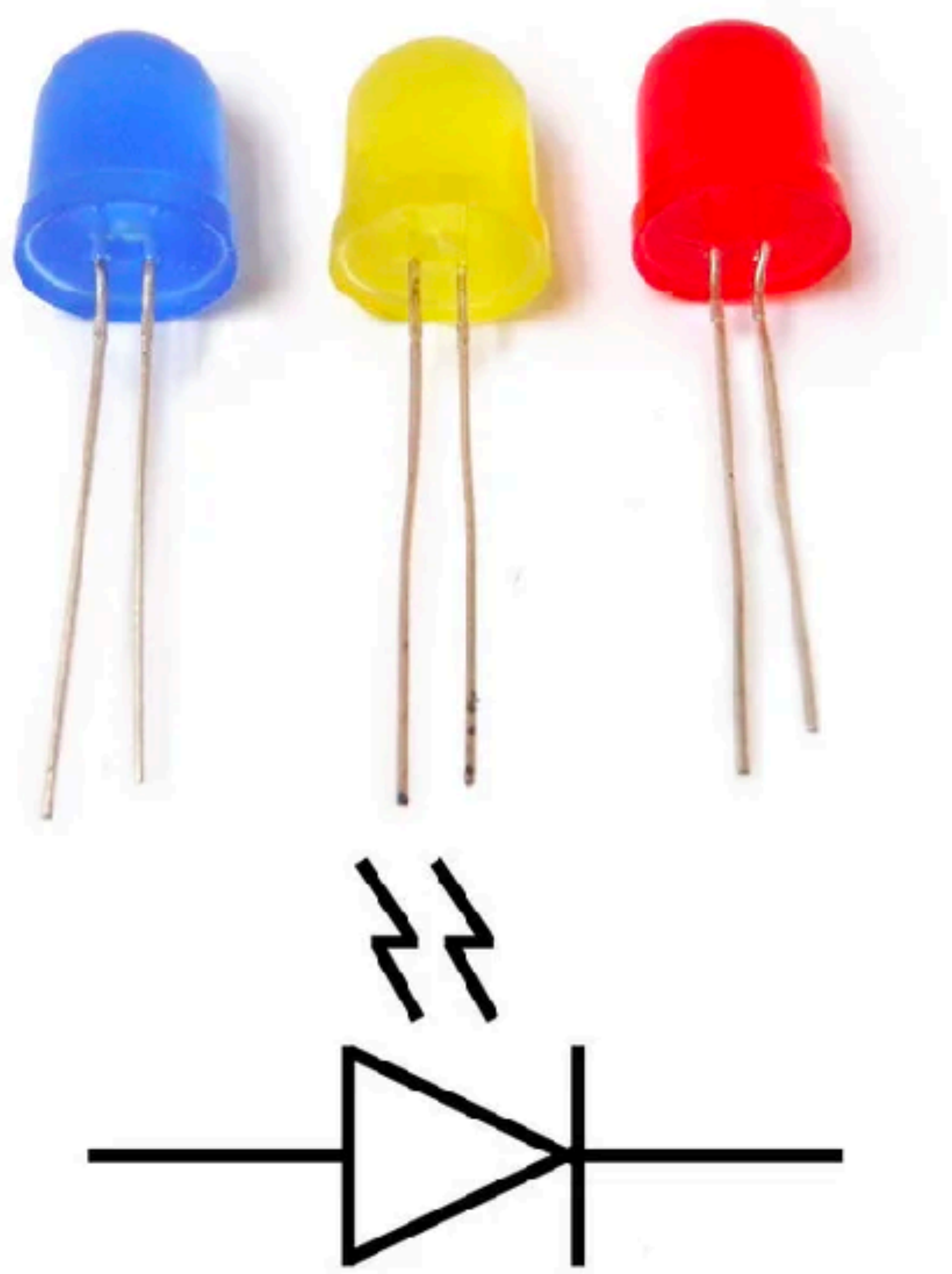
- A description of the project.
- A material & parts list.
- Images of iteration and process
- A clear, strong image or images of the completed project.
- A list of all materials you tried

Your documentation should include a circuit diagram as well as a picture of your circuit.

Kits Overview



https://www.instructables.com/id/Basic-Electronics/



LED

Light Emitting Diode

Polarized component

Often 1.5-3.3 volts

Battery (volts)

CR2032 (coin cell) 3v 220 mAh

AA 1.5 v 2000 mAh

9v 400-600 mAh

Other cool conductive materials demo

- Fabric
- Copper Tape
- Magnet Wire

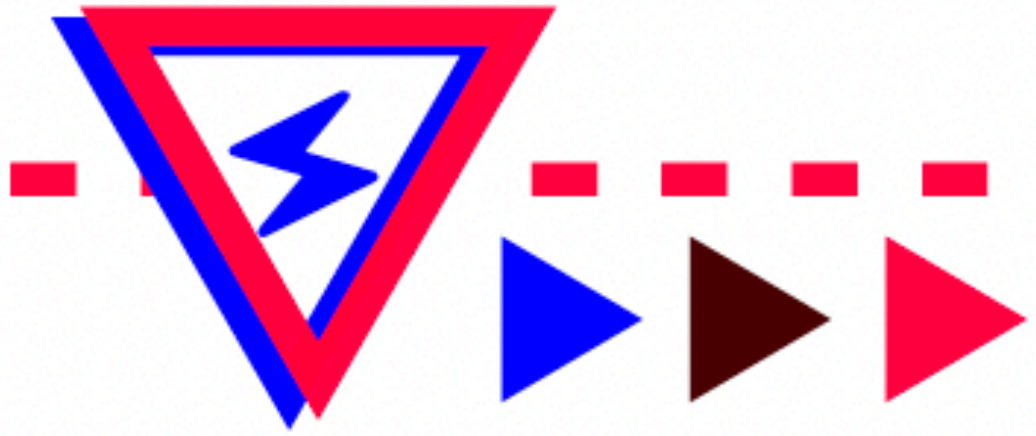
Everything in the kit is used to help us control the flow of electricity.

Electricity can react with different materials, producing light, vibrations, sound, magnetism or other phenonmon! Thats what we call electronics!

watt is power?

Voltage is the amount of energy, and amperage how fast it is flowing. Therefore, we can calculate wattage as the change in voltage over time.

When you plug something into the wall, it uses energy by converting into another form, for example like heat from a kettle. In this case, wattage is the amount of electrical energy converted into heat over time.



power = how much x how fast

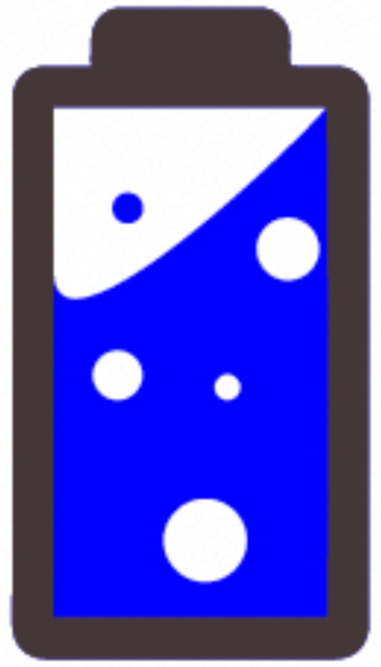
wattage = voltage x amperage

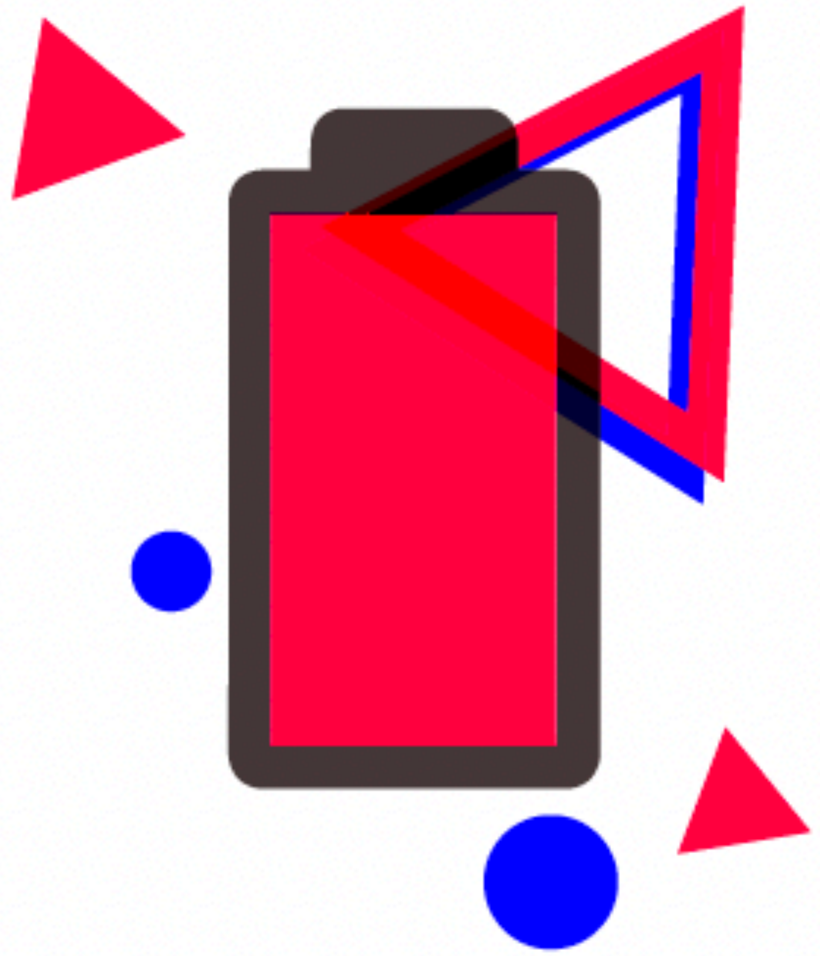
Wattage is current moving through the circuit over time at a particular strength (voltage)

10 watts is:

1 volt at 10 amps
10 volt at 1 amp
2 volt at 5 amps
5 volt at 2 amps

The reason a battery has a certain amount of voltage is because there is a chemical combination that has the potential to supply a certain amount of potential energy measured in volts.





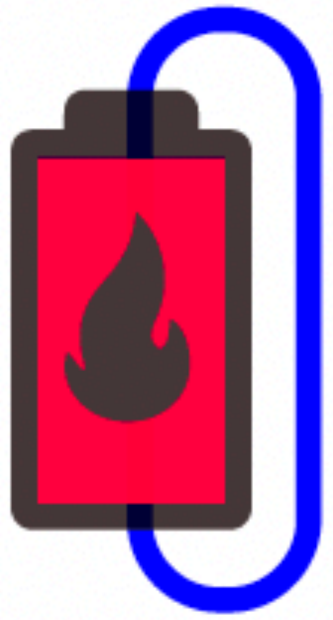
Filled with potential energy, a battery just wants to reach its lowest energy state. We can take advantage of this by attaching a circuit that does something useful while the battery gets rid of its energy. A battery discharges completely when the reaction inside the chemistry is done, achieving a natural state. A dead battery :(

If we connected a battery's terminals together with a magical, non existent material that lets energy flow freely, it will discharge at an infinite rate into itself! But that's impossible because *everything* has some **resistance** - a property that slows or stops the flow of current.

we must resist the flow!

resistance is measured in ohms

Ω



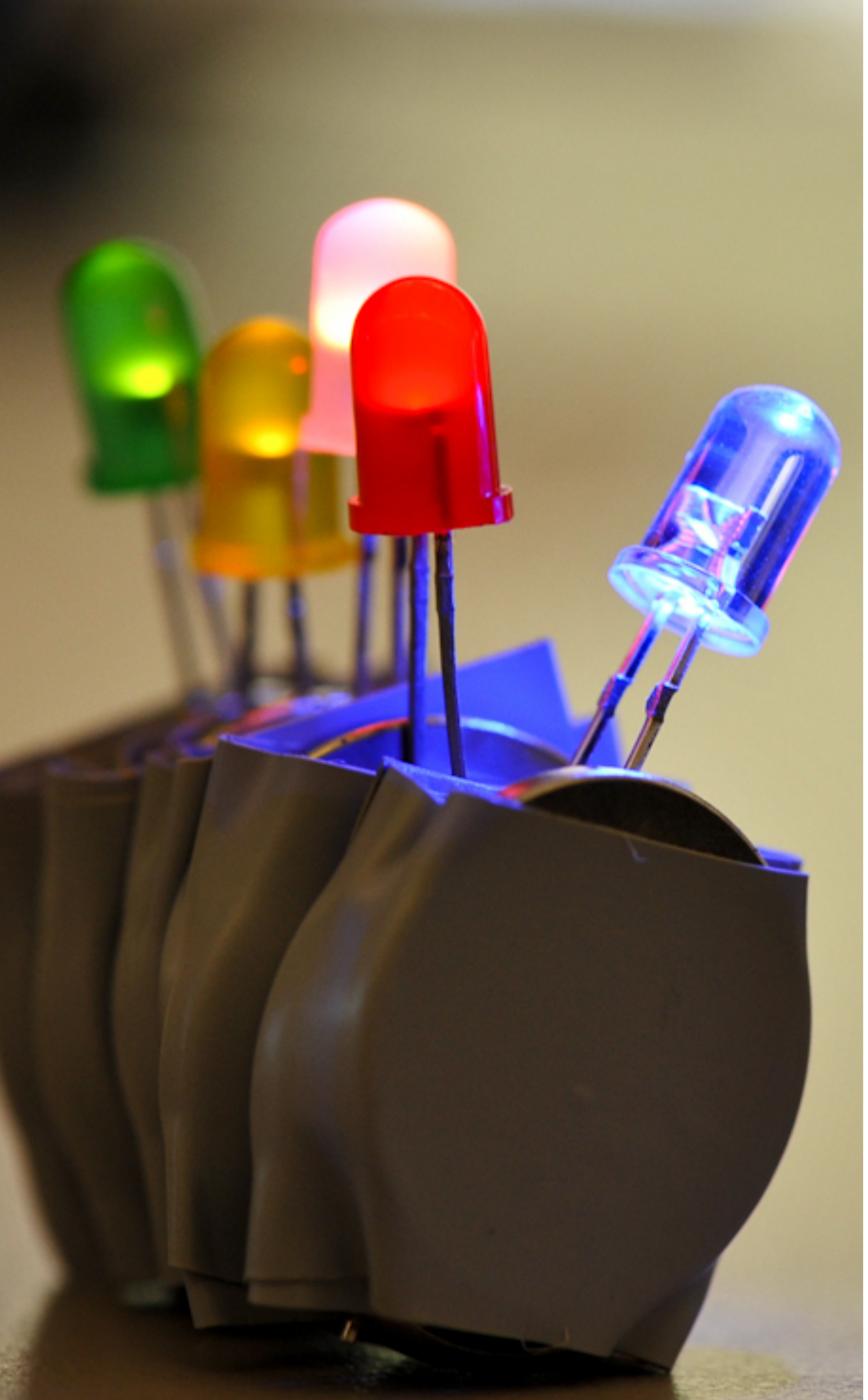
If you connect a wire with very little resistance to each terminal, it will discharge at its maximum discharge rate into itself. This could damage the battery because it will generate heat. The voltage will be used up quickly because of the high current - it's flowing very quickly.

That's a short circuit!

The more resistance in a circuit, the slower the flow of electricity (current). With a very high resistance, a battery will last longer! A battery has an "amp hour" rating, which is how many amps per hour it can supply - or how much the current can flow before it's depleted. A wall power supply has an amp rating, or how much current it can tolerate at a sustained rate, since it won't be depleted like a battery.

Resistors create a fixed resistance, but every component in a circuit also has some resistance !

Current in small circuits are often measured in milliamps (mA), or capacity in milliamp hours (mAh)



In our LED + Battery circuit, there is not very much resistance, so our LED will burn out pretty fast. You can put a current limiting resistor in order to keep it going longer!

Lets slow the flow!

There is a proportional relationship between resistance, voltage, and current in a circuit. That means by changing one, you effect the others in a (mostly) predictable way.

This relationship is called Ohms Law

I = current (amps)

V = voltage (volts)

R = reisstance (ohms)

LED Color	Typical Vf Range
Red	1.8 to 2.1
Amber	2 to 2.2
Orange	1.9 to 2.2
Yellow	1.9 to 2.2
Green	2 to 3.1
Blue	3 to 3.7
White	3 to 3.4

First, how much voltage is our LED using? usually ~ 2v (depending on color) and often work best at 10ma. (1 amp is 1000 milliamps). You can usually find this on the LED packaging.

The LED operates best at 2v and the battery is 3v!

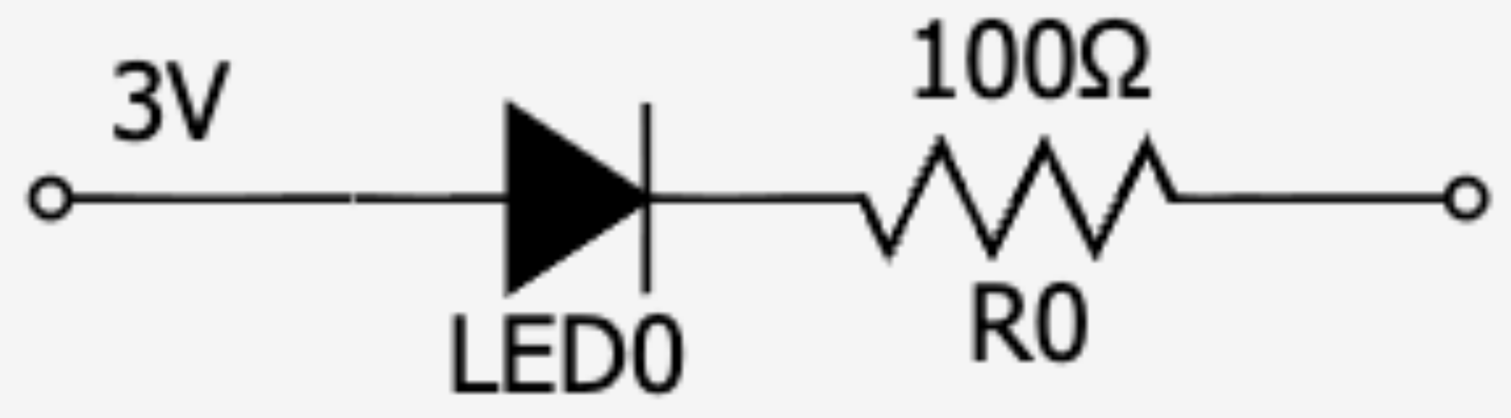
Resistance = Voltage / Current

R = V / I

R = (3 - 2) / 0.01

R = 100 (ohms)

(Voltage is supply - used voltage)



Current Draw:	10mA

Resistor (Ohms, Ω, or k (kilohms))

Resistors help us slow down the flow.

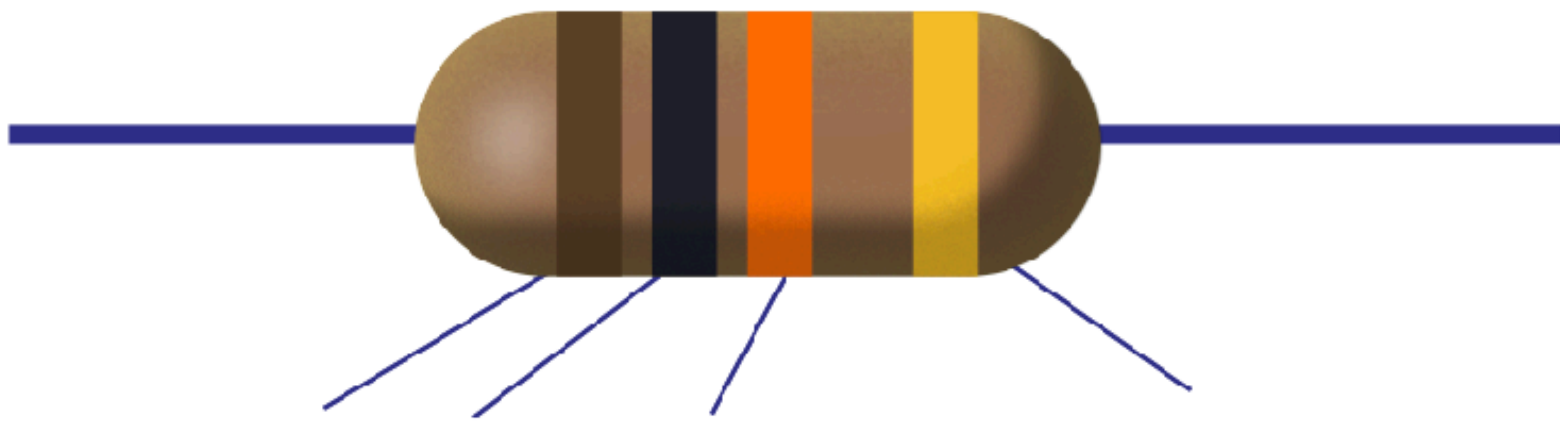
Reading Resistors

The colors on a resistor indicate the value by using a code. There are acronyms, like BBROYGBVGW, (Big Beautiful Roses Occupy Your Garden But Violets Grow Wild) but theres nothing wrong with looking up the chart.

The first 2-3 bars indicate the numeric value, the fourth is the multiplier, and the last is the tolerance.

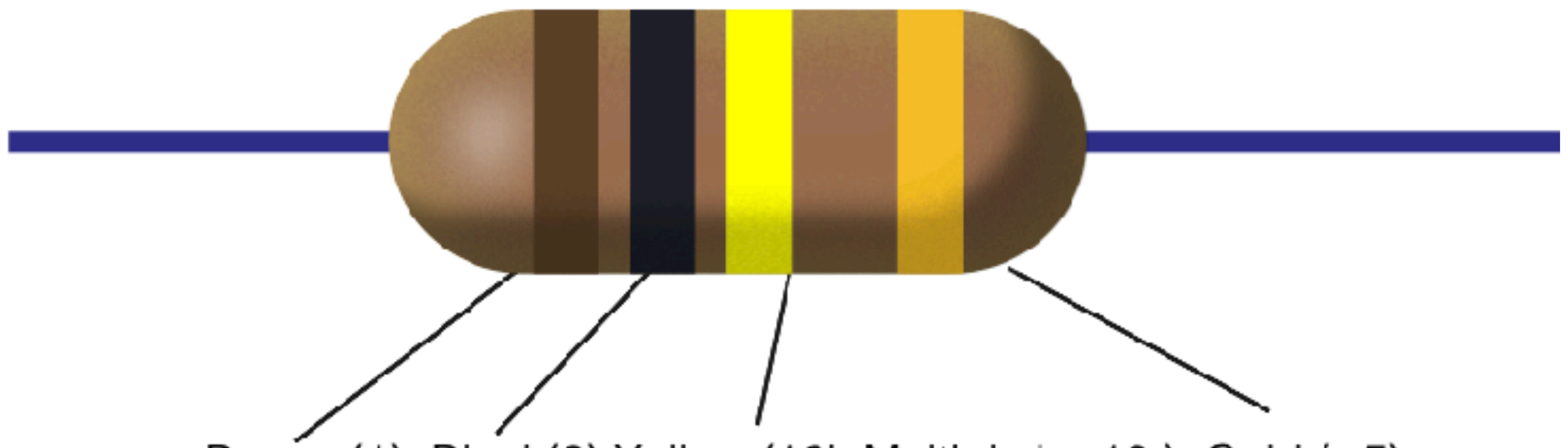
1	Big	0
10	Beautiful	1
100	Roses	2
1k	Occupy	3
10k	Your	4
100k	Garden	5
1m	But	6
10m	Violets	7
100m	Grow	8
1g	Wild	9

10k resistor

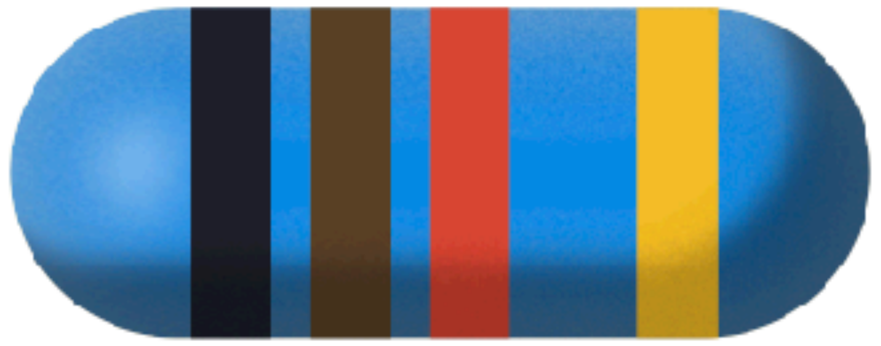


Brown (1) Black (0) Orange (1k Multiply by 1) Gold (+5 +/- 5% accuracy)

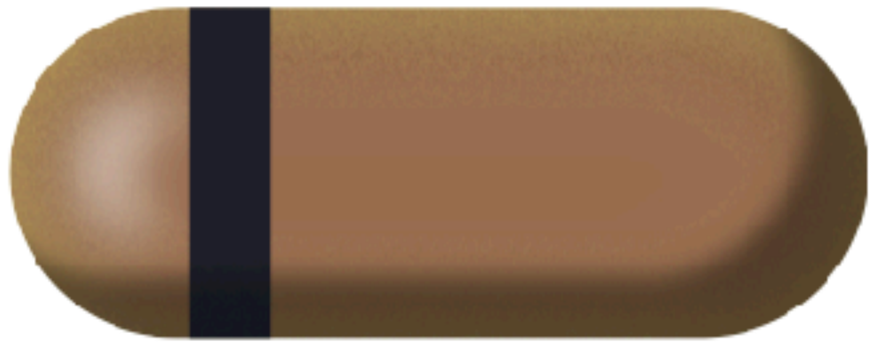
100k resistor



Brown (1) Black(0) Yellow (10k Multiply by 10) Gold (+5)



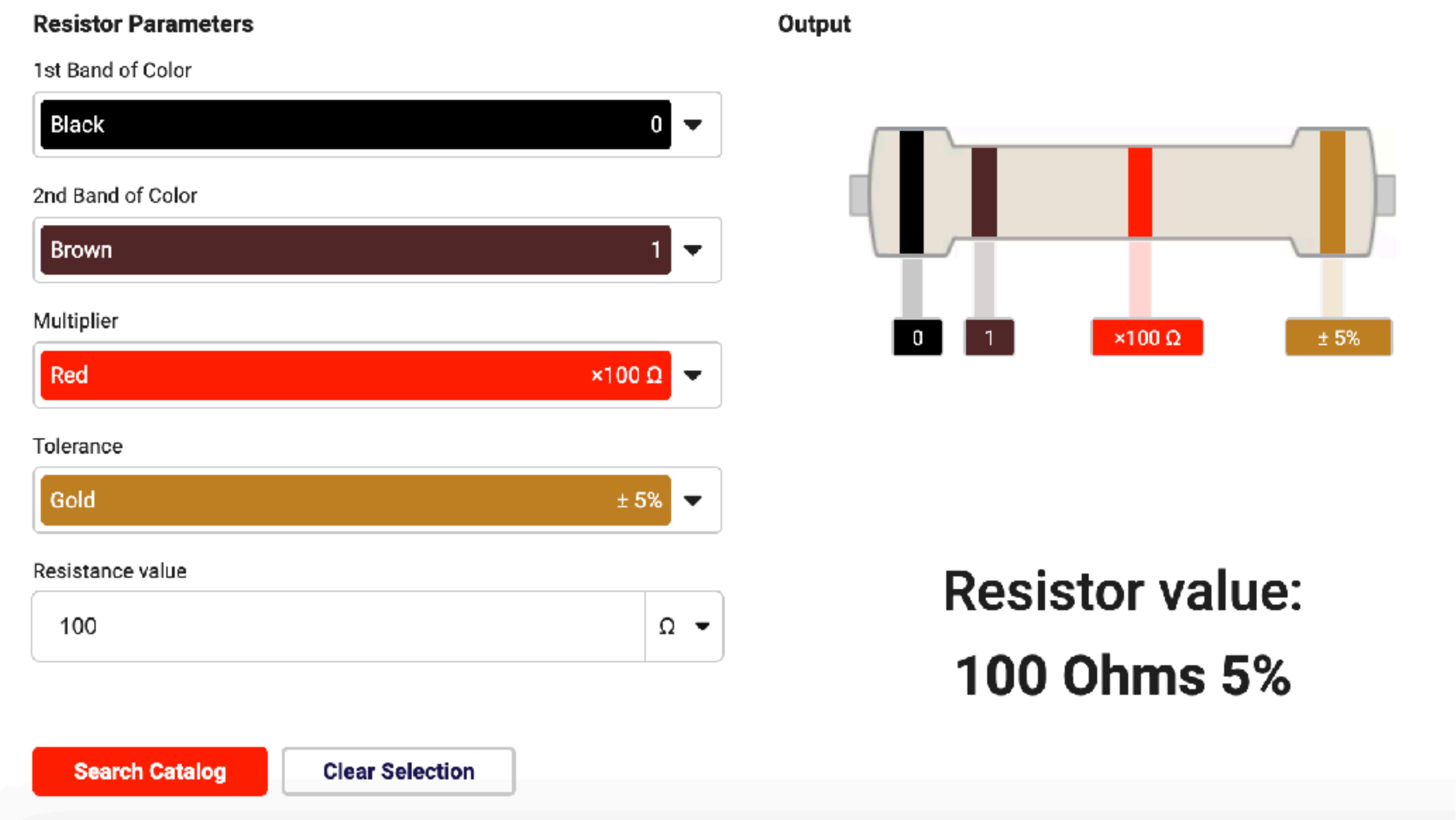
Blue body resistors are usually high precision!



Zero ohm resistors have no resistance, but can be used in a circuit that requires a resistor componen

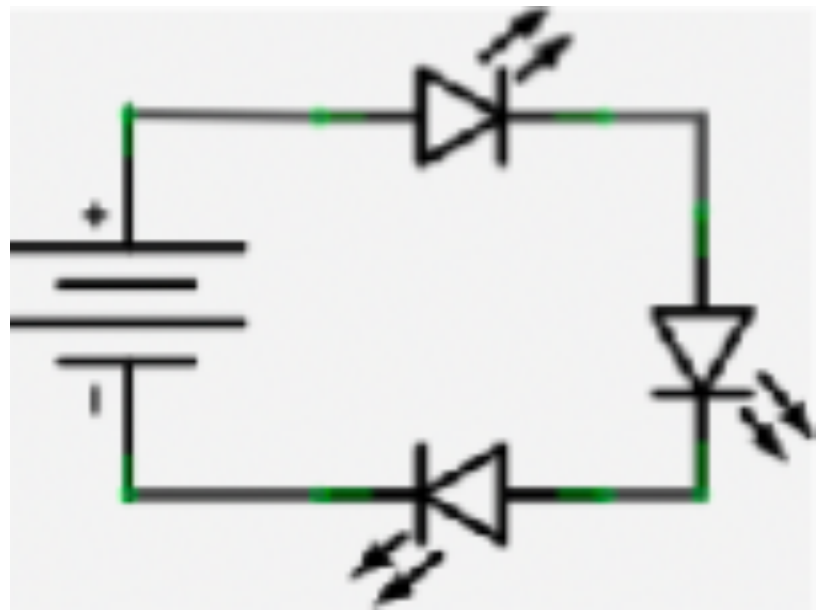
Its hard to memorize… Use a resistor calculator, or label your resistors.

https://www.digikey.ca/en/resources/conversion-calculators/conversion-calculator-resistor-color-code



What if you want to have more LEDs?

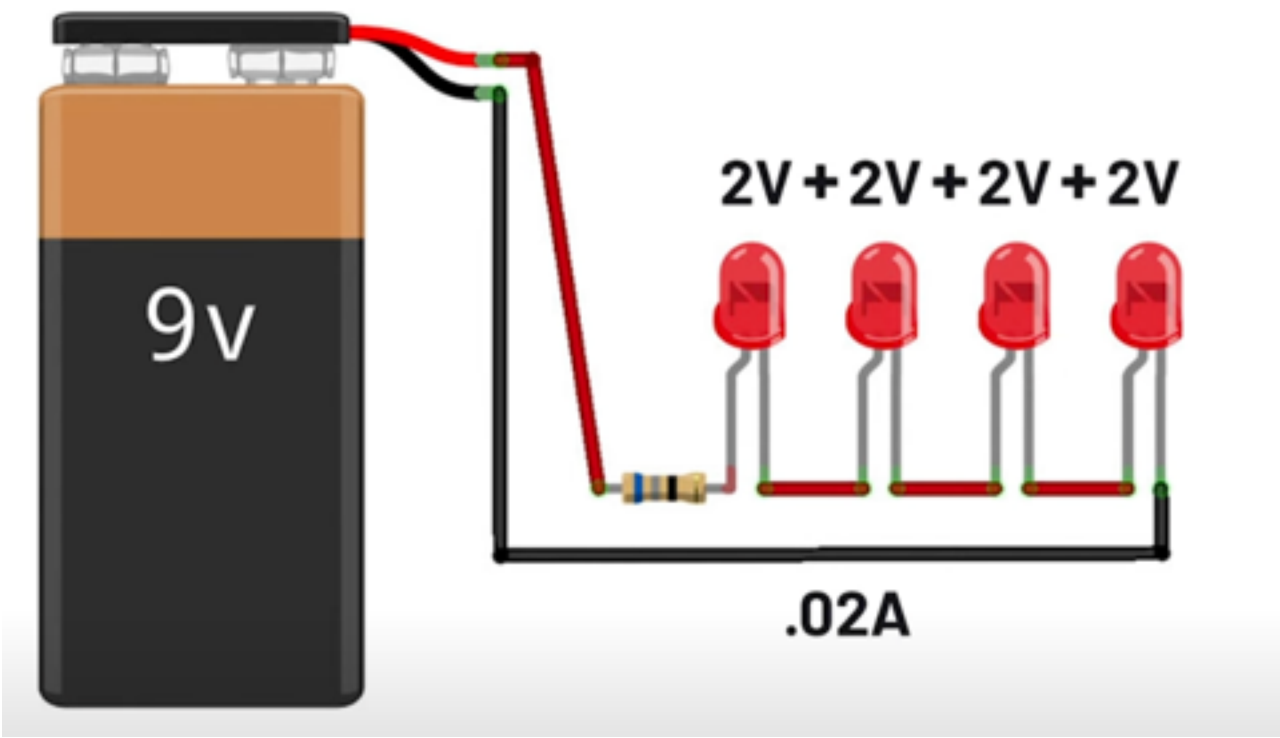
Series



In a series, components, like LEDs, are connected in a row. Electricity flows through one, into the next, and then into the next. Here, the positive is connected to the negative in a chain. There is a single path for the electricity to flow.

In a series circuit, the voltage is divided among the components. So if we have 3, 2v LEDs we need 6 volts to power them.

Series



In this example, 4x 2v LEDs uses 8v

We have a 9v battery

We need to use that extra volt for the circuit to last longest and not damage the components

$R = V / I$
$R = (9 - 8) / 0.024$

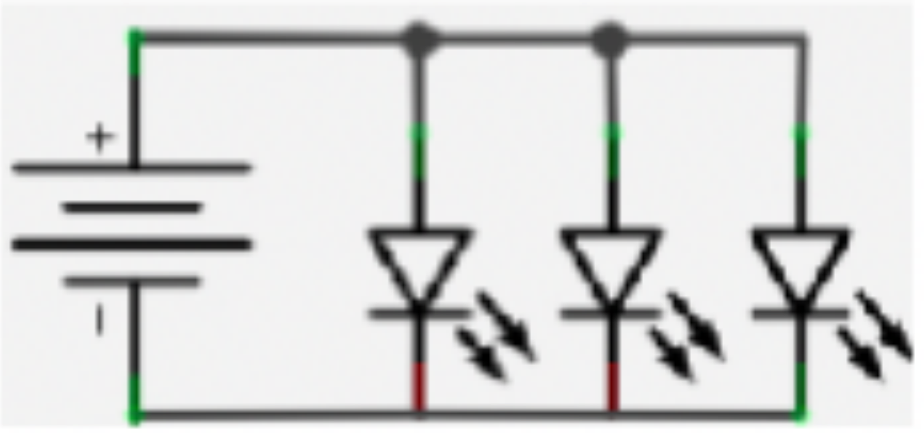
$R = 50$ (ohms)

Series

In Series, Positive connects to Negative, connects to Positive, connects to Negative ect…. Voltage is divided among the components and current remains constant.

If you're using lots of LEDs in series, you might need a really high voltage. Which is why for simple LED circuits we usually don't see them configured this way

Parallel

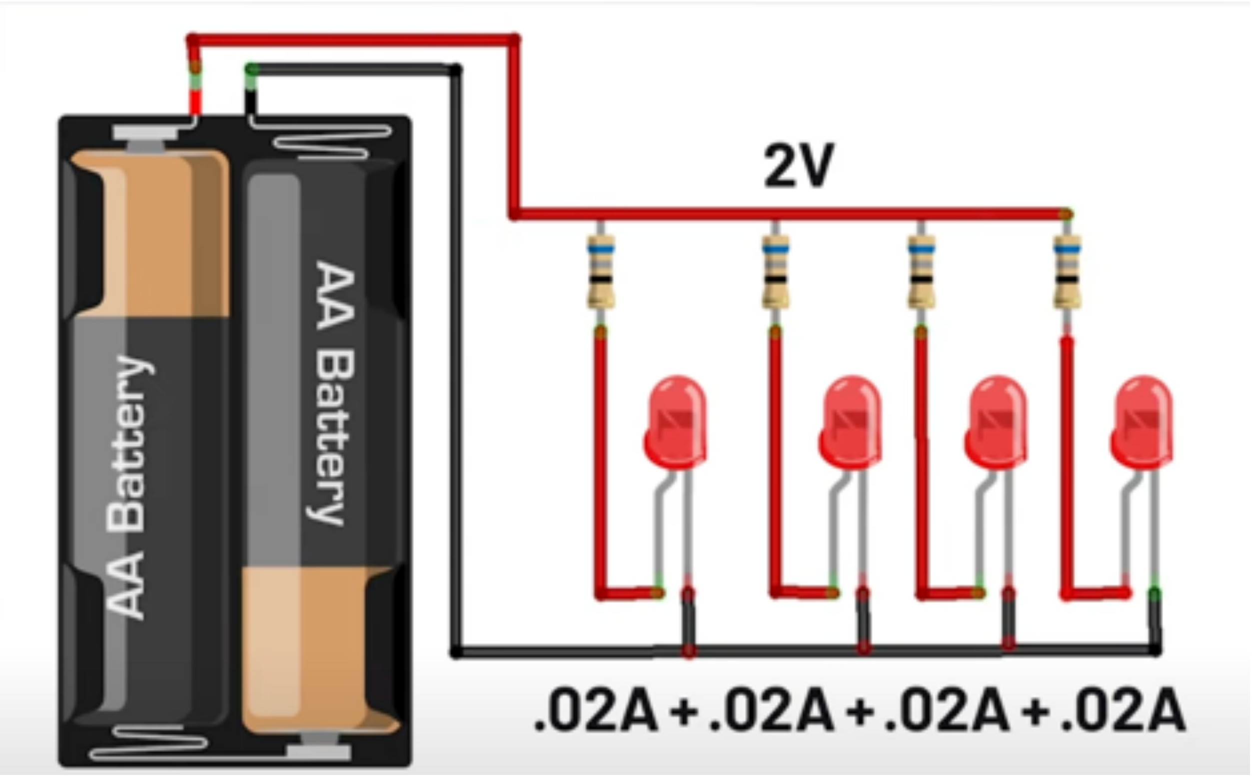


In a parallel configuration, components are connected side by side, each with an independent connection to power and ground. You can think of this like all of the positives are connected, and all of the negatives are connected.

In this situation, each LED receives the same amount of voltage, but the current is divided between them. So if we have 3, 2v LEDs we only need 2v to power them.

Usually circuits with lots of LEDs are in parallel.

Parallel



In this example, we're using a 3 v (2x 1.5v) battery.

In a parallel circuit, we put the resistor on each LED

R = V / I

R = (3 - 2) / 0.2

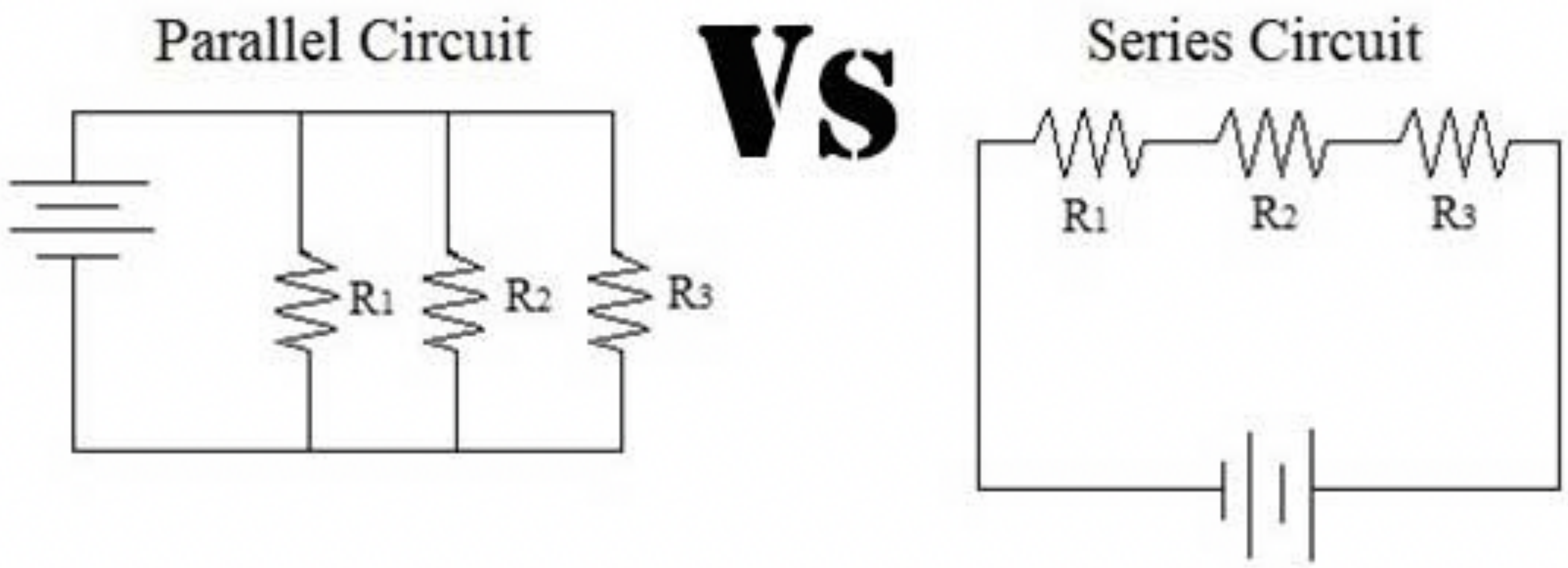
R = 50

Parallel

In Parallel, all the Positives are connected, and all the Negatives are connected. **Current is divided through each LED, voltage stays the same.** We can connect many LEDs like this! As long as we have enough current, we can power many LEDs at the same voltage

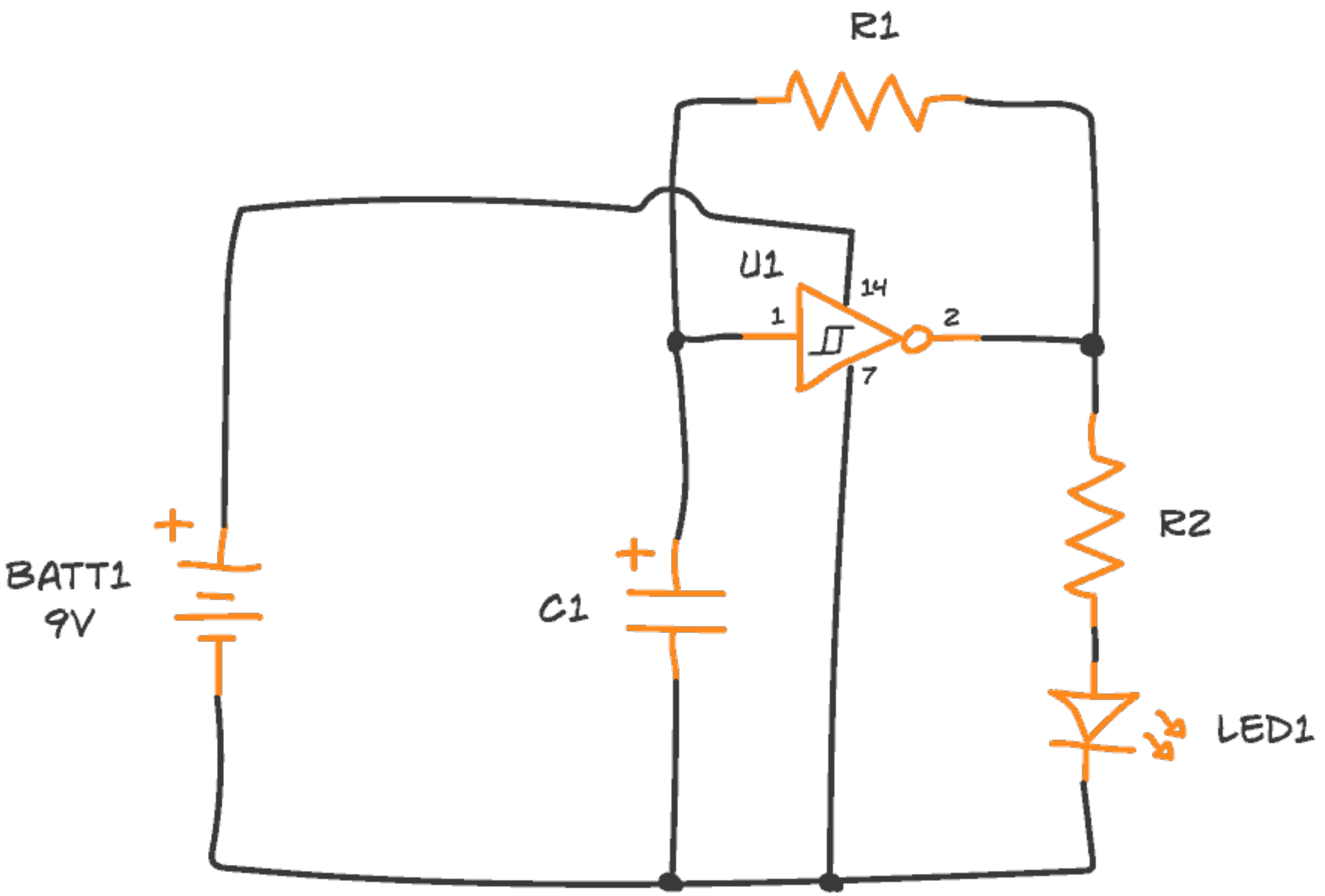
If your LEDs are 3v, and your power source is 3v, you can run as many as your amperage will allow. But you can always add more batteries.

Series Vs Parallel



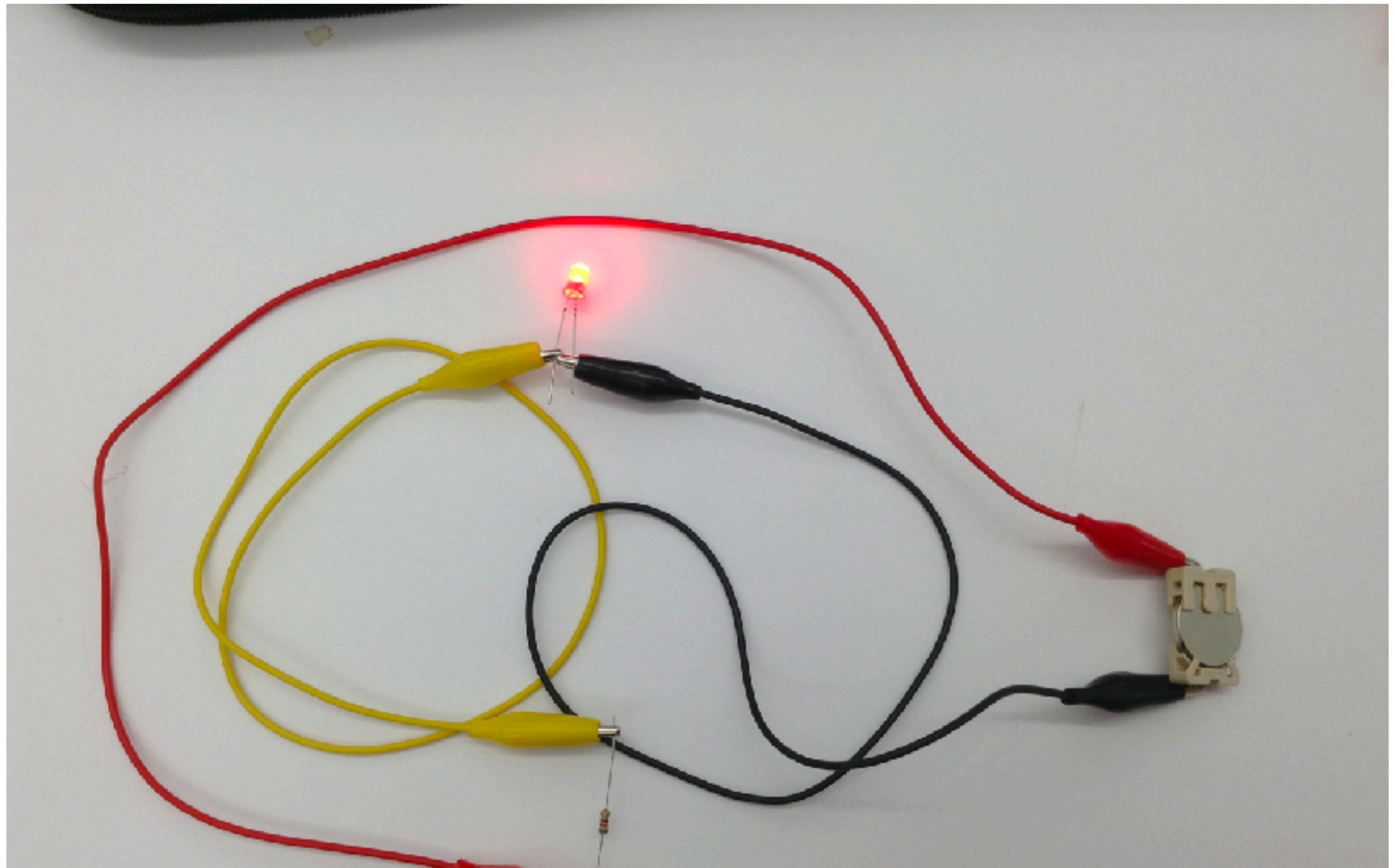
Circuit Diagram

Circuit diagrams use symbols describe circuit construction, but they might not always describe how a circuit looks!

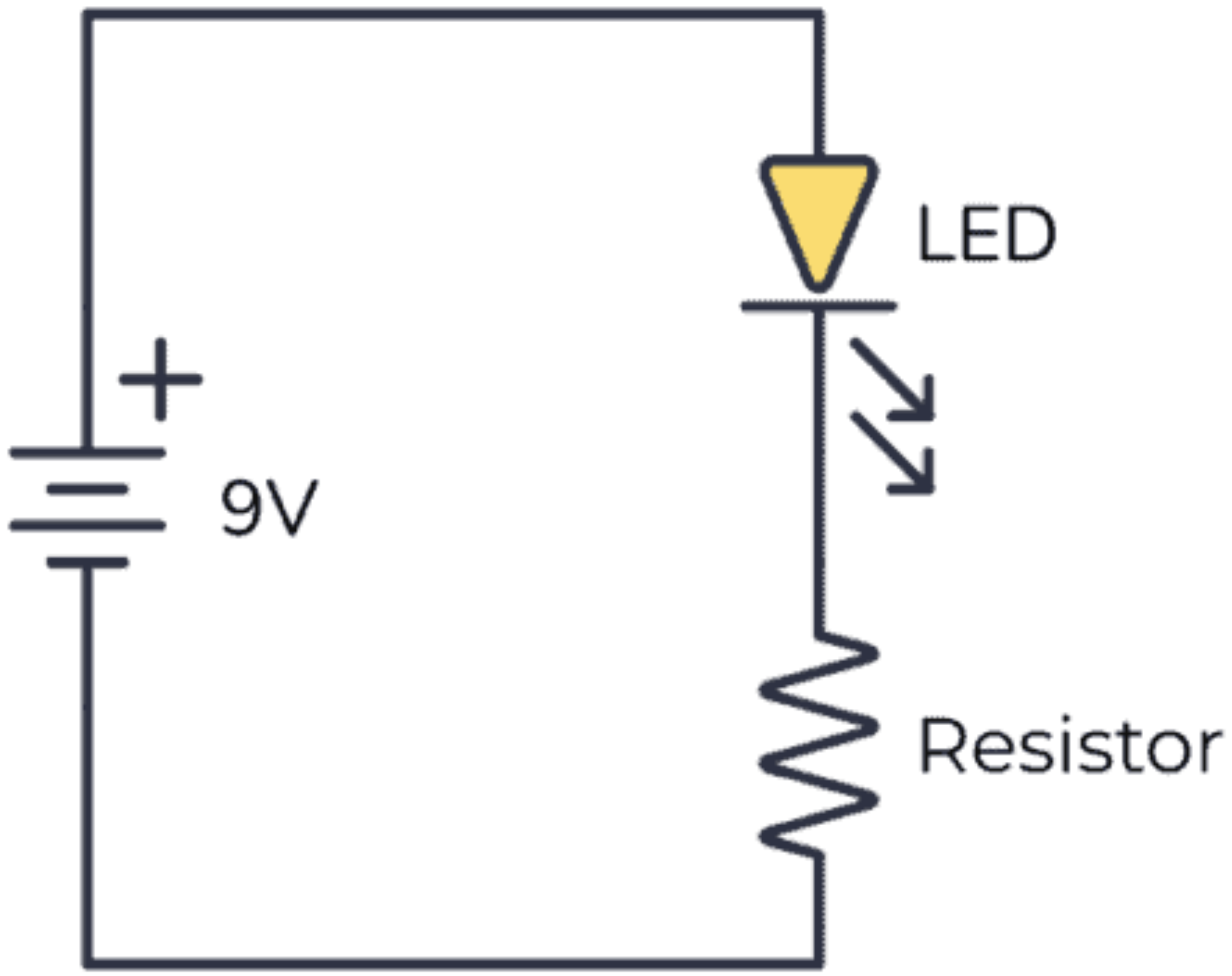


Circuit Aesthetics

- Diagrams just indicate how the circuit should be wired, but you circuit can look different!
- As long as all of the connections are made in the correct orientation, and there are no shorts, your circuit will work



Your circuit diagram can look like this

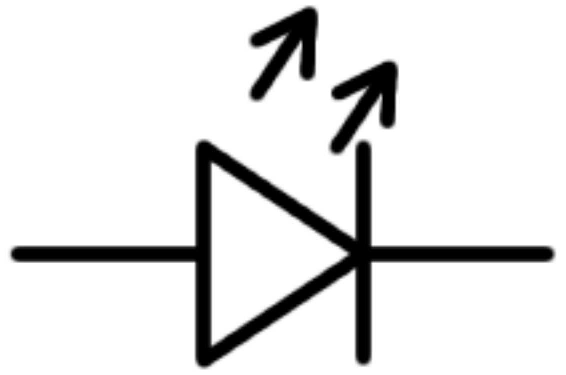


And your circuit might look like this

Becky Stern

Circuit Diagram

This is a battery 

This is an LED 

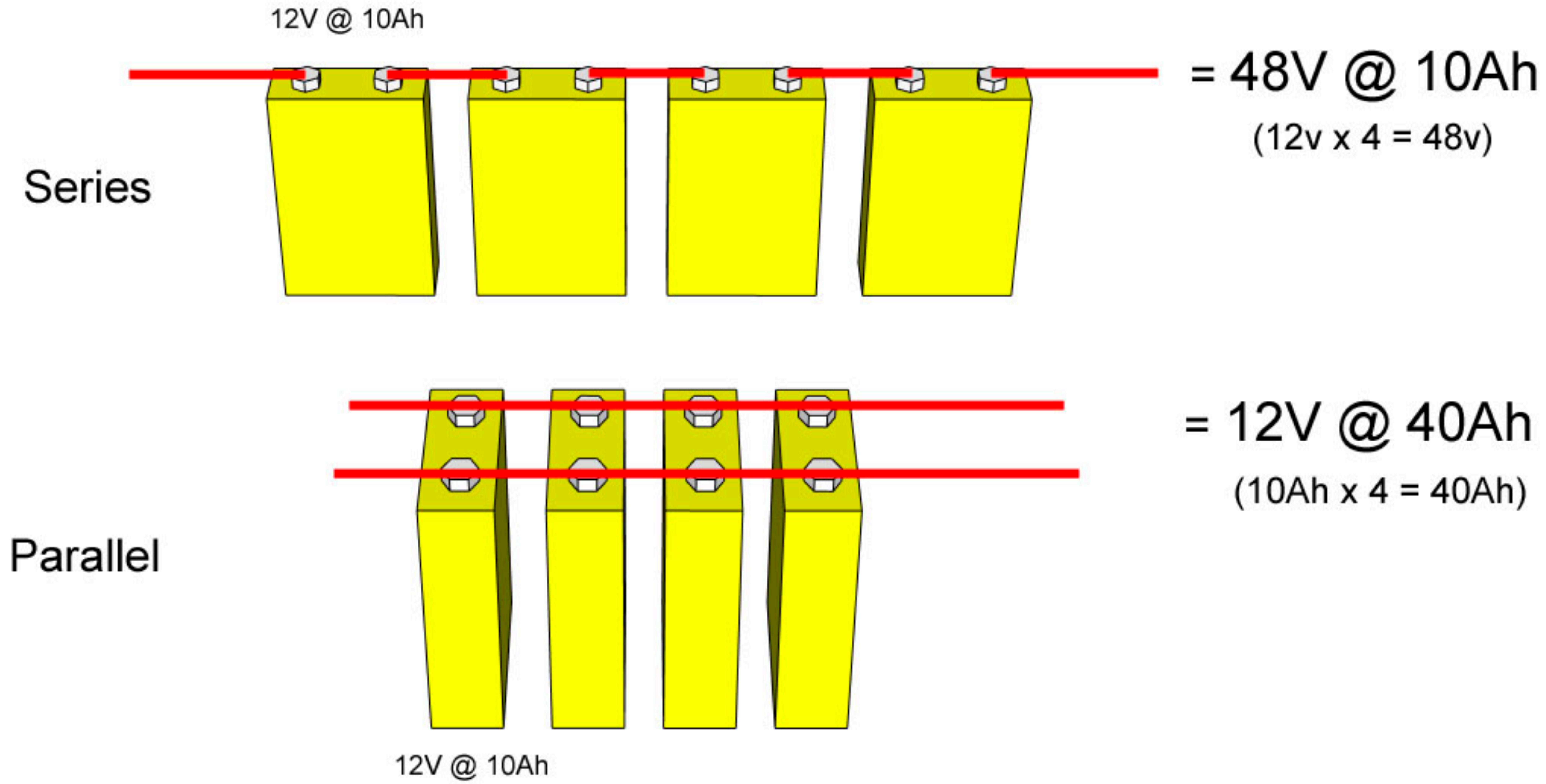
This is a resistor 

...Do we really need resistor if the light goes on?

Maybe not. But your circuit might not last long, might behave weirdly, or you might have more problems down the road, but if that doesn't bother you, do whatever you want! If you have too much voltage, you can risk damaging your component forever.

What if you need more power....

You can use Series and parallel to add more power to your circuit, using the same principals. **Putting batteries in Series will increase your voltage, and putting batteries in Parallel will increase your amperage.**


12V @ 10Ah
Series
= 48V @ 10Ah
(12v x 4 = 48v)
Parallel
= 12V @ 40Ah
(10Ah x 4 = 40Ah)
12V @ 10Ah

How long will my battery last?

Add up the total current in your circuit.
Find the battery capacity (mili amp hours),
divide capacity by hours!

Current flowing is voltage of your circuit divided by resistance

Let's say we have a coil of wire that has 30 ohms of resistance per cm. We have a battery that has 9 volts and 500 mAh.

1 cm of wire
30 ohms

This circuit uses 300 milliamps
9 volts / 30 Ohms = 0.3 amps

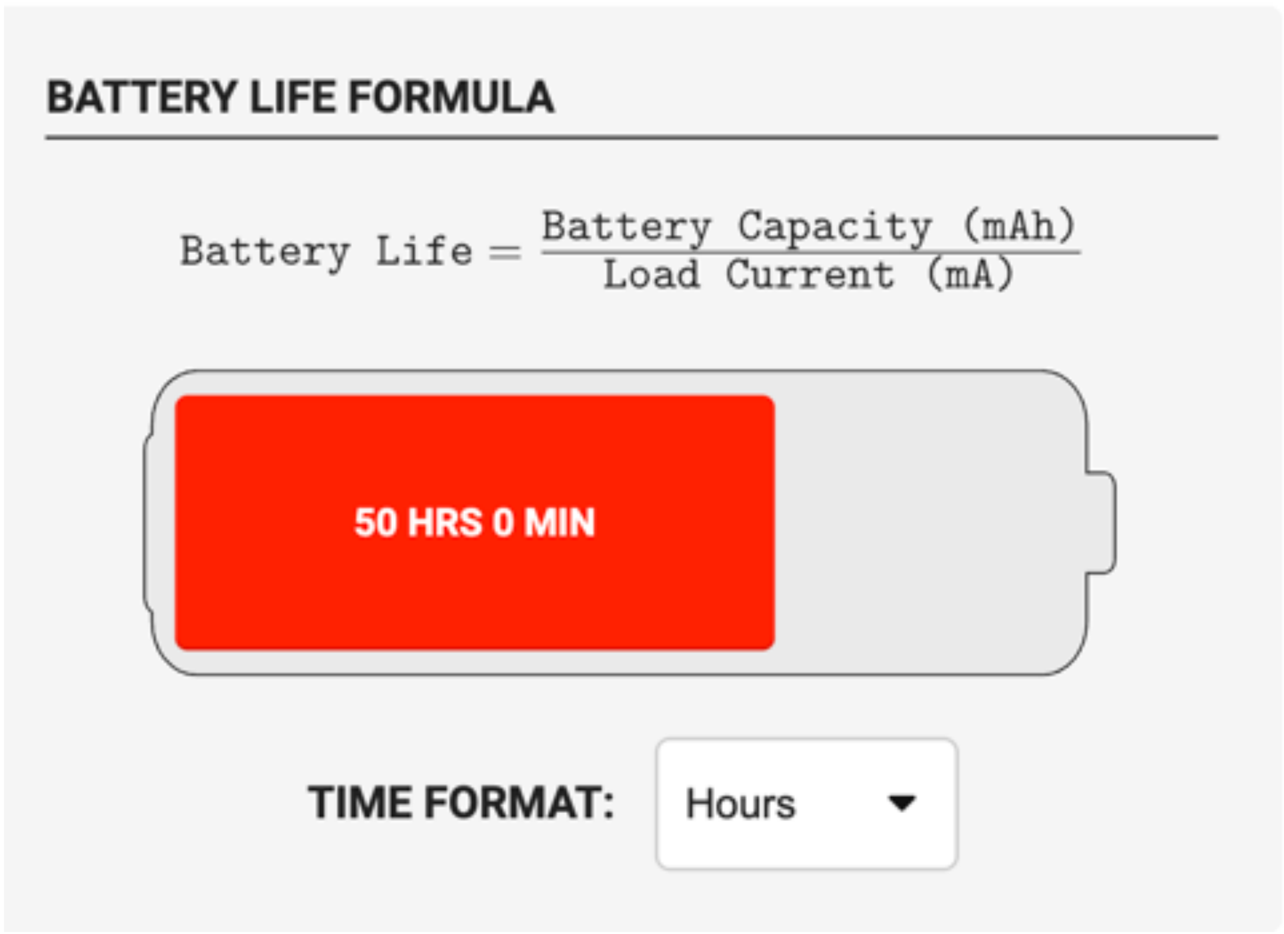
500mAh / 30 mA
my battery will last **1.67 hours**.

This circuit uses 60 milliamps
9 volts / 150 Ohms = 0.06

5 cm of wire
150 ohms

500mAh / 60mA
my battery will last **8.3 hours**.

Battery life is the milliamp hours of a battery divided by the milliamps used.



Design your circuit with (informed) trial and error, and/or use a calculator

https://www.amplifiedparts.com/tech-articles/led-parallel-series-calculator?srsltid=AfmBOoo-ZP0CAuRCuXK75L4Ur1nEZAgMdfsrVQX8PBDAJq65bbdlc0fz

This one is great because it gives you lots of options.

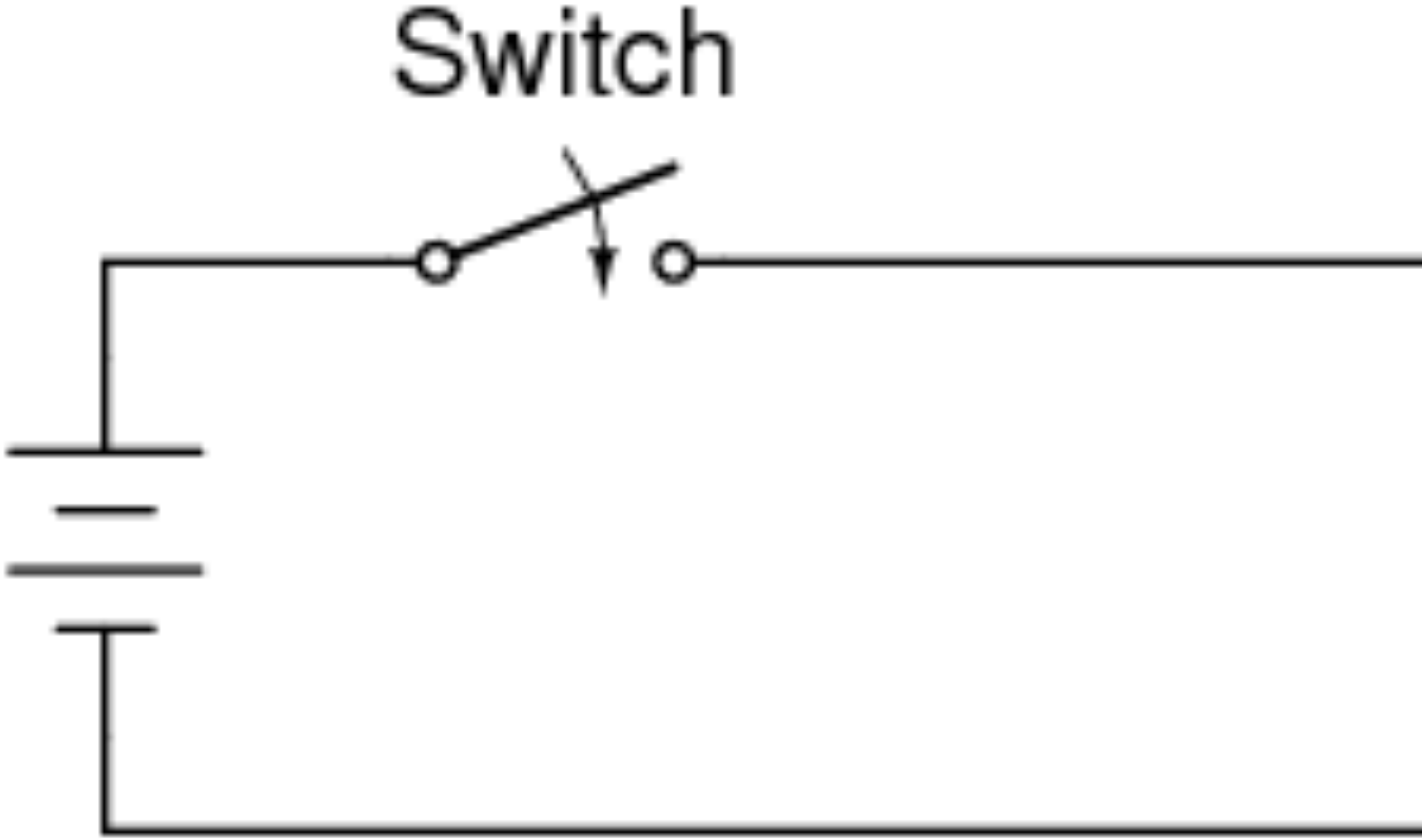
If you circuit has too much Voltage (v) for your components, you'll break them. For the most part, your circuit will only use as much Amperage (I, mAh, Ah) as it needs, but your circuit might not work properly or battery might run out very fast. You can use Resistance (Ohms) to control this. Each component has a voltage rating (check the packaging).

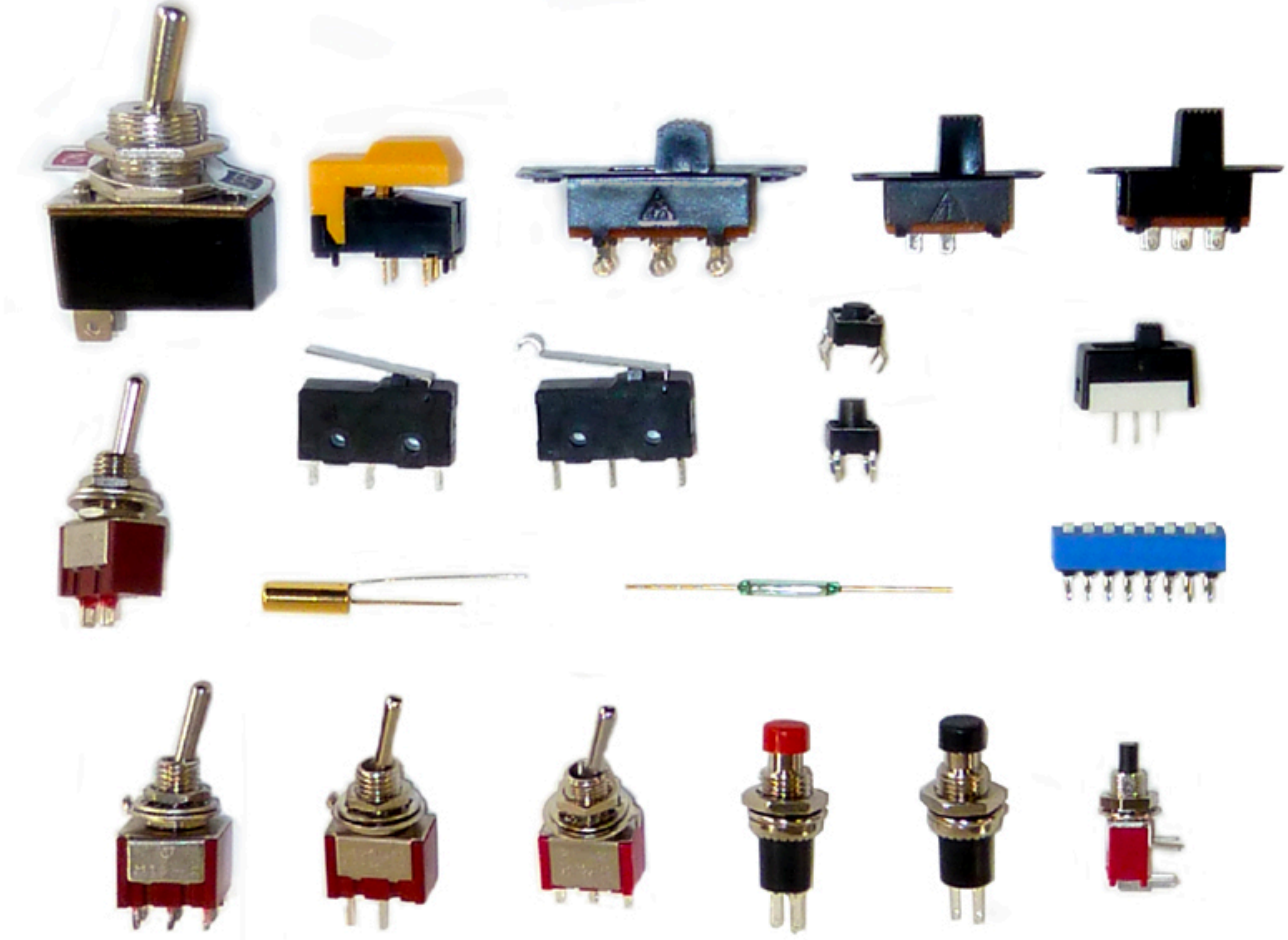
Buttons And Switches

Button / Switch?

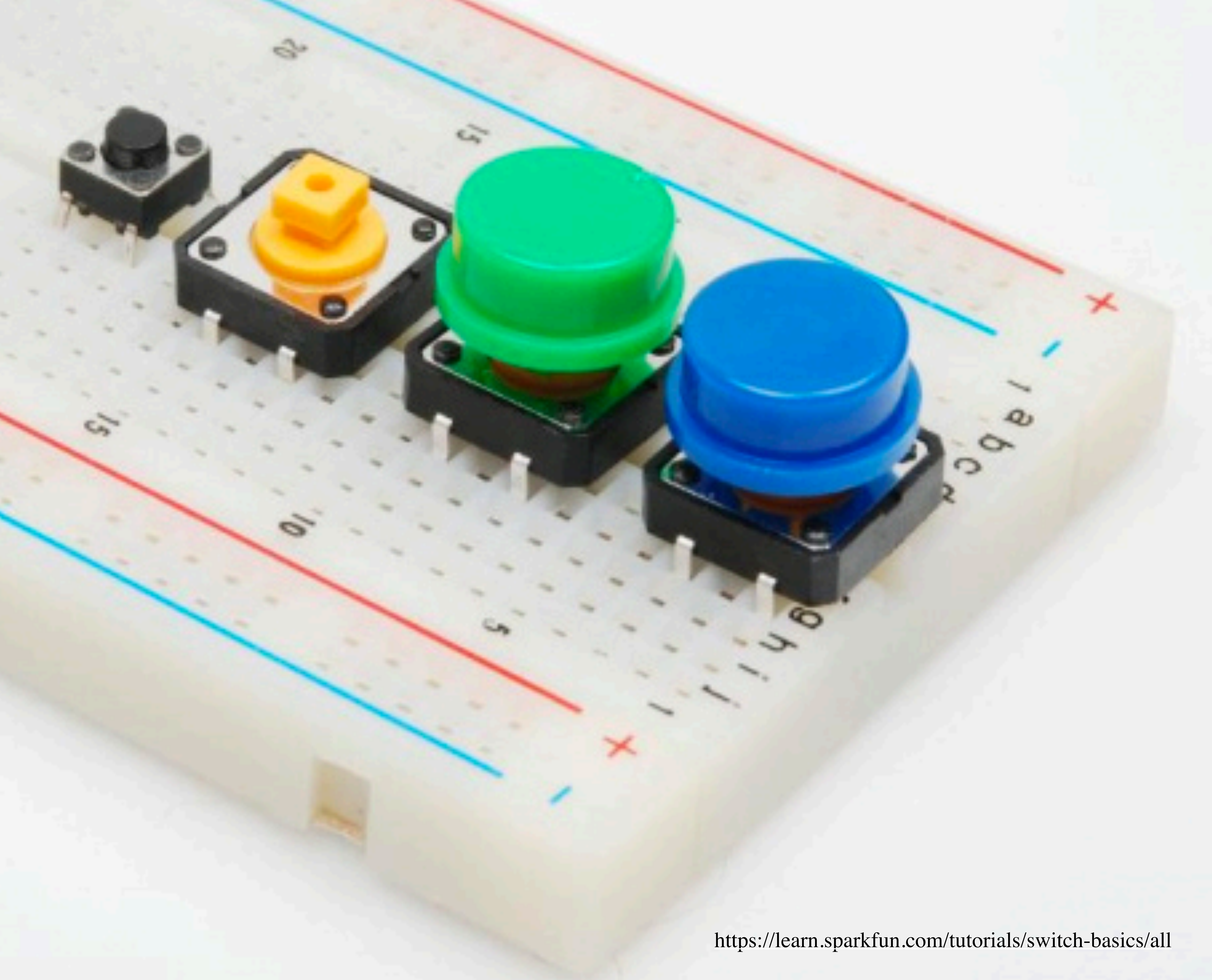
A button or a switch is a break in a circuit that can be connected via some action.

Often, but not always, buttons are pressing two things together, and switches are changing the placement of one or more objects


Switch

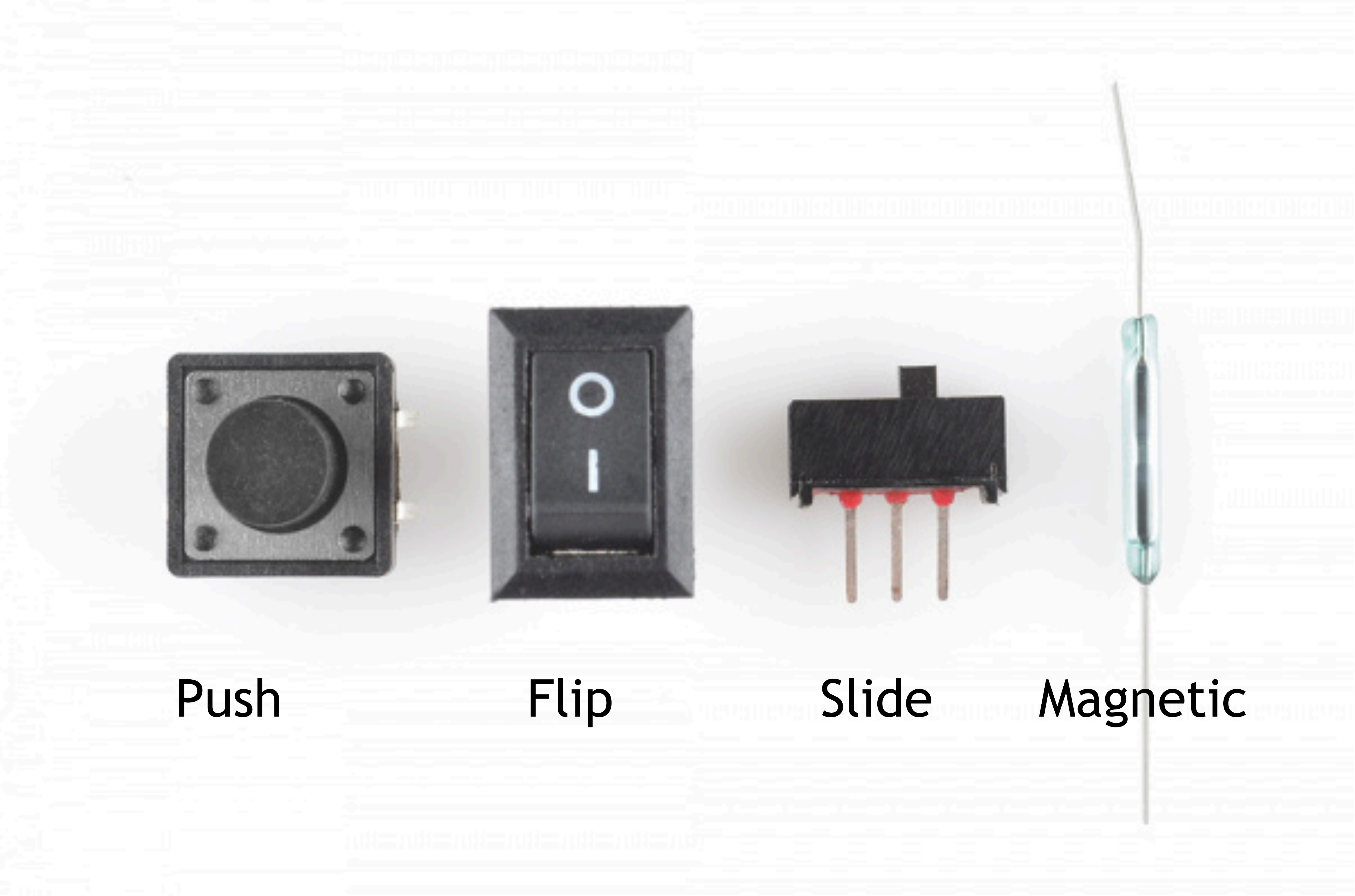


Sparkfun Tutorial



https://learn.sparkfun.com/tutorials/switch-basics/all

Activation Method



A switch must have at least two terminals, one for the current to (potentially) go in, another to (potentially) come out. That only describes the simplest version of a switch though.

Poles

The number of **poles*** on a switch defines how many separate circuits the switch can control. So a switch with one pole, can only influence one single circuit. A four-pole switch can separately control four different circuits

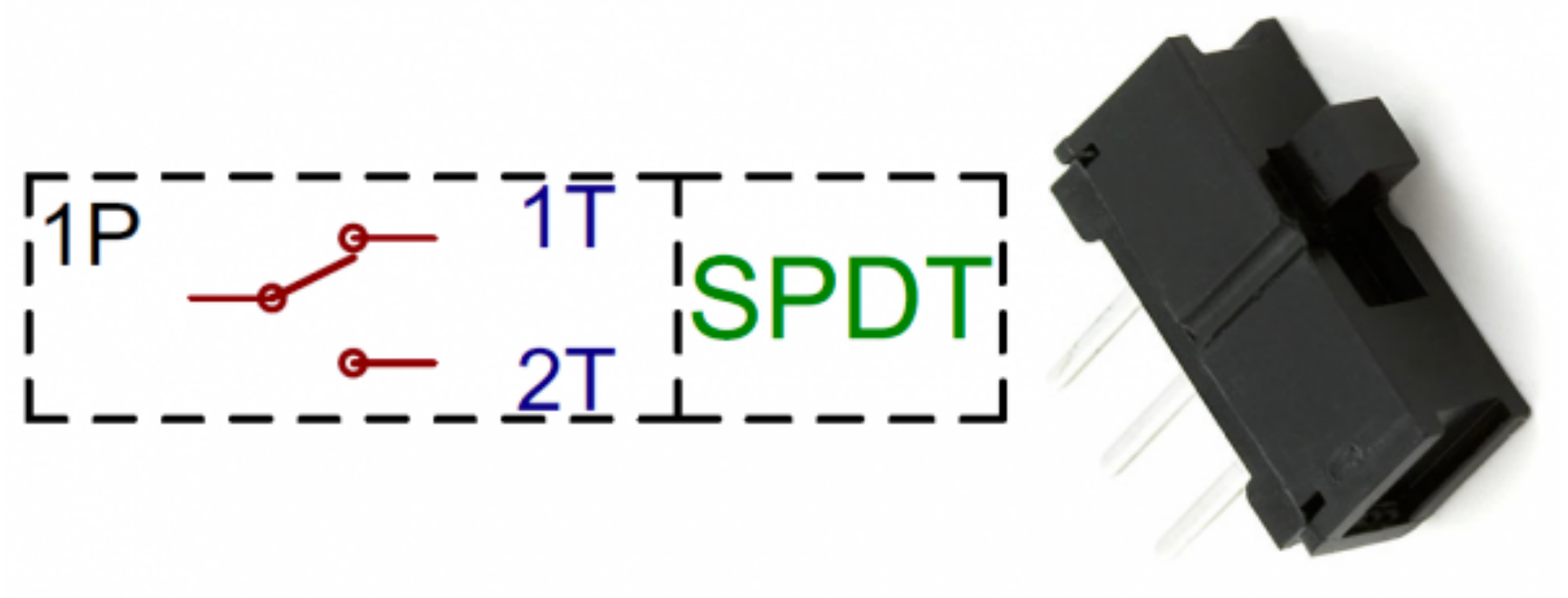
Throws

A switch's **throw**-count defines how many positions each of the switch's poles can be connected to. For example, if a switch has two throws, each circuit (pole) in the switch can be connected to one of two terminals.

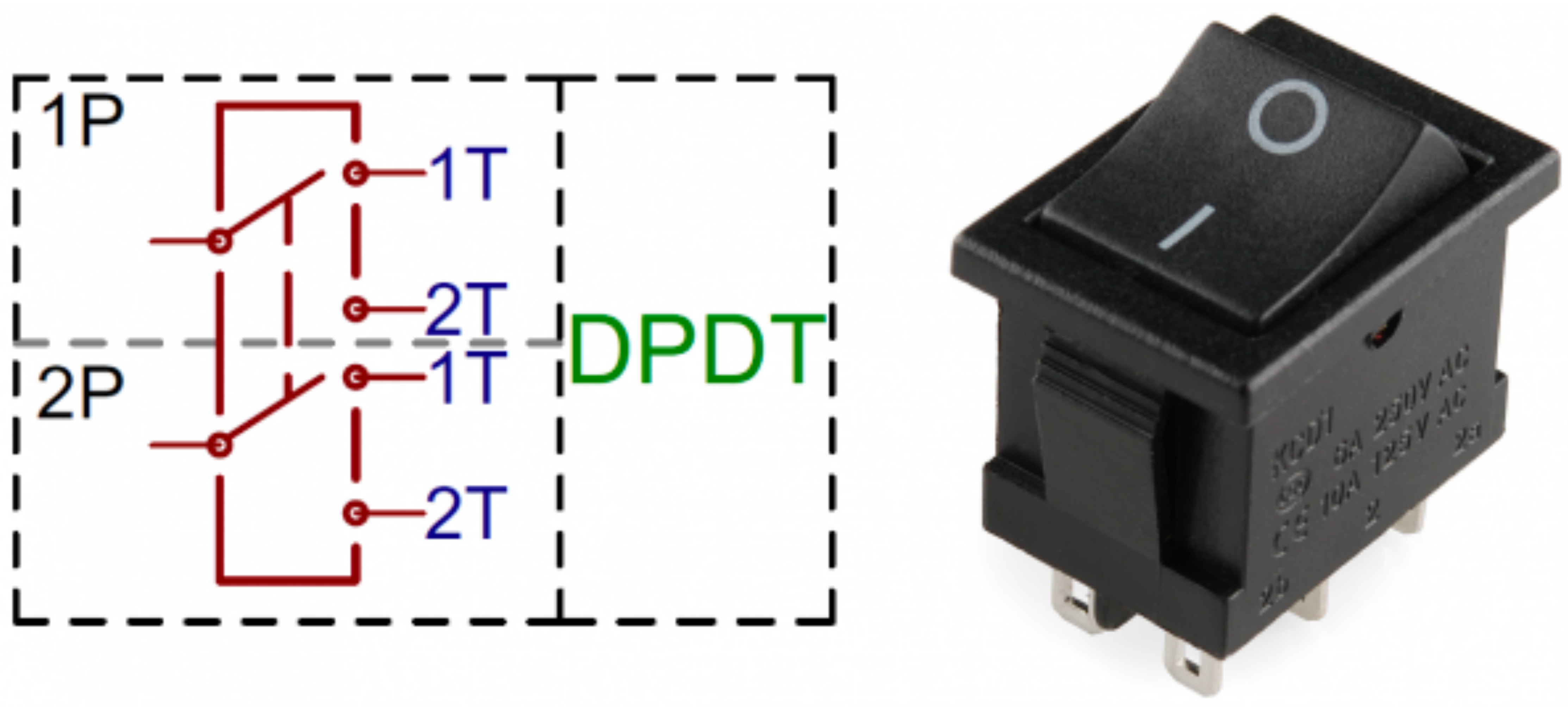
SPST Single Pole Single Throw

Most common are like this, its how
We often think of switches

Single Pole Double Throw



Double Pole Double Throw



4 Pole Double Throw 4PDT

Momentary

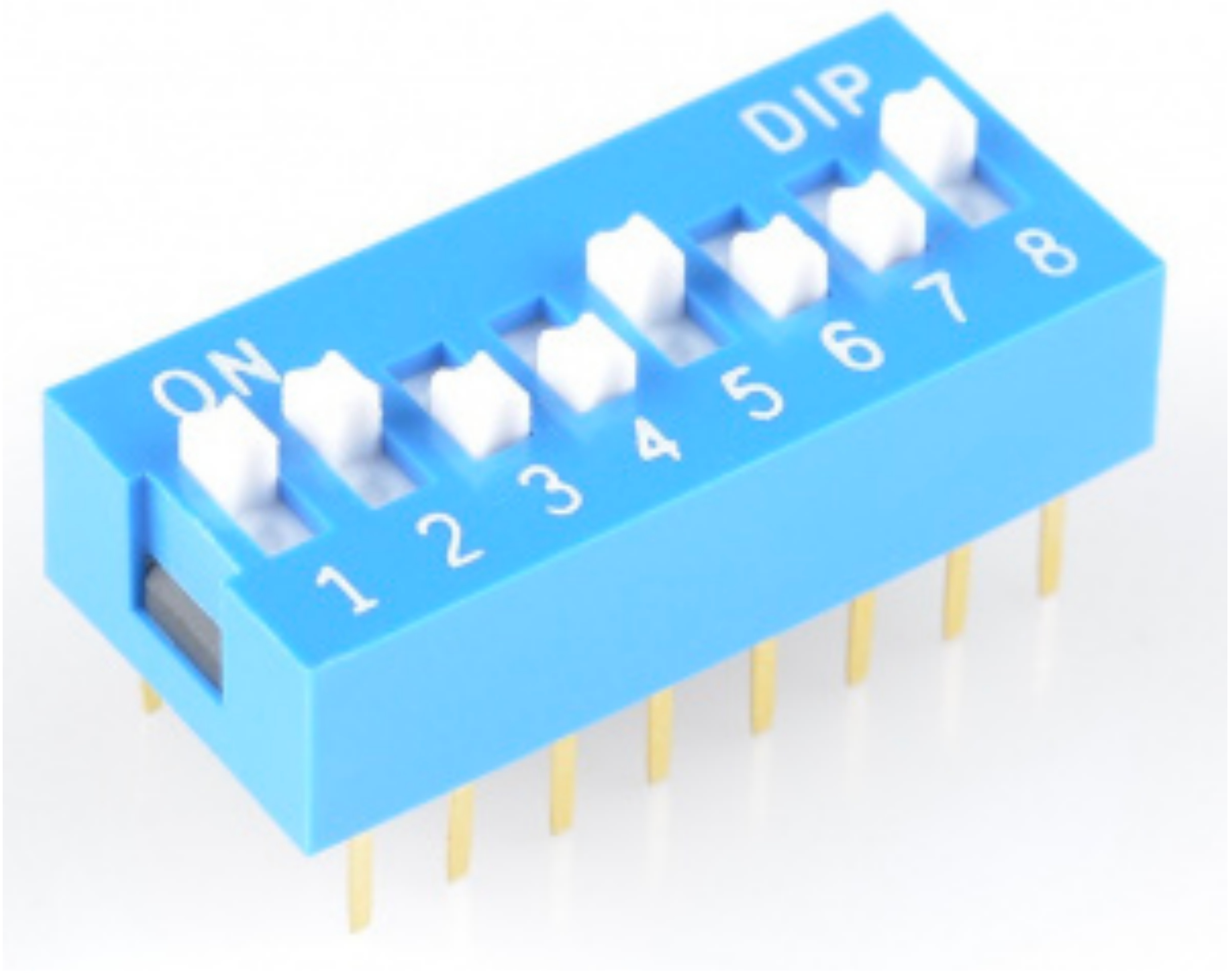
Momentary buttons or switches are only activated when they are being pressed.

Normally Open (NO)

When nothing is happening, the circuit is open (off)

Normally Closed (NC)

When nothing is happening, the circuit is closed



State

State buttons or switches have multiple positions they keep when they aren't being held in that place. Like a power button.

SPST (Single Pole Single Throw) state, NO (normally open) flip switch

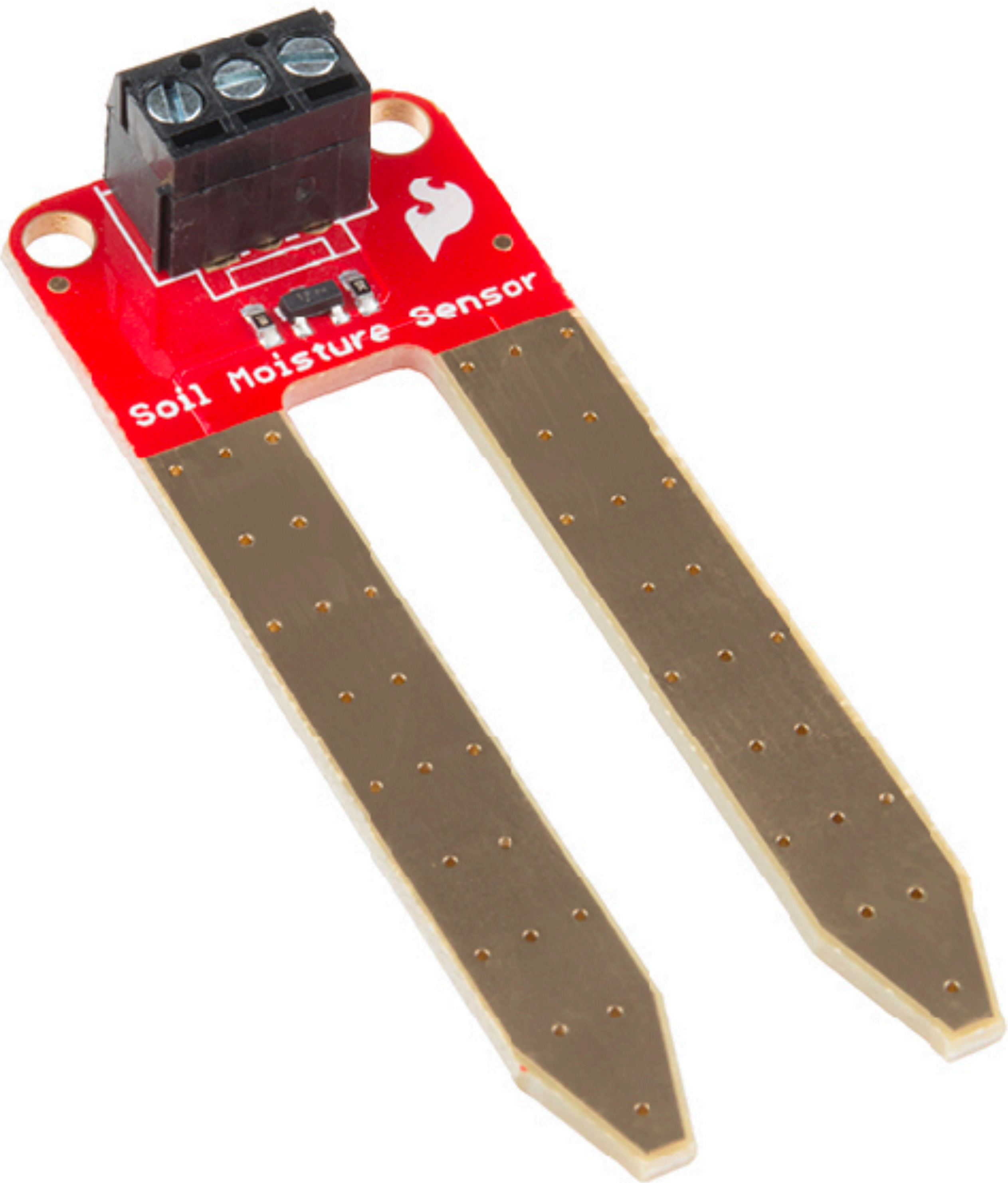
DPDT NC,
momentary
push button

Buttons and switches as sensors?

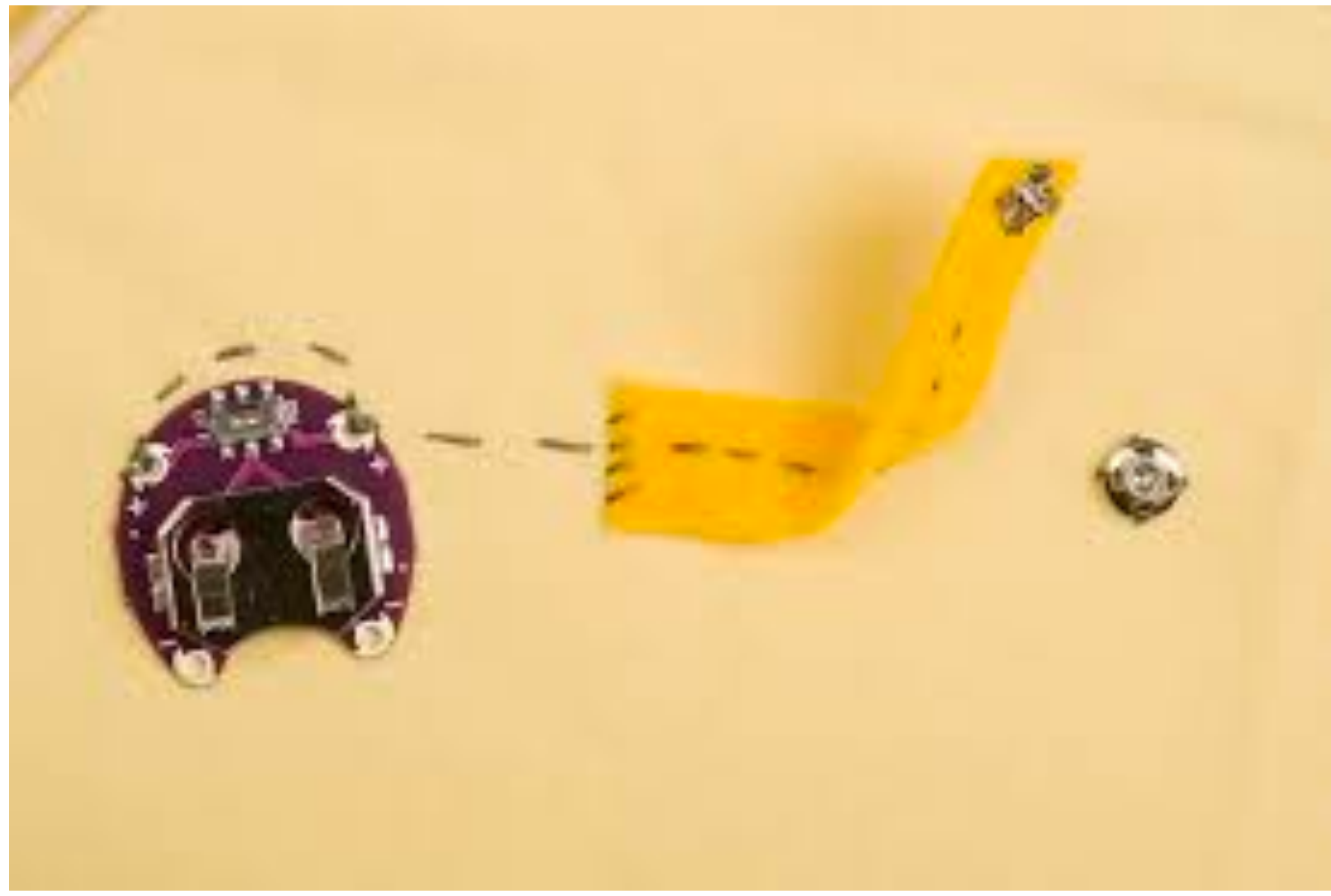
Magnetic Switch / Reed Switch

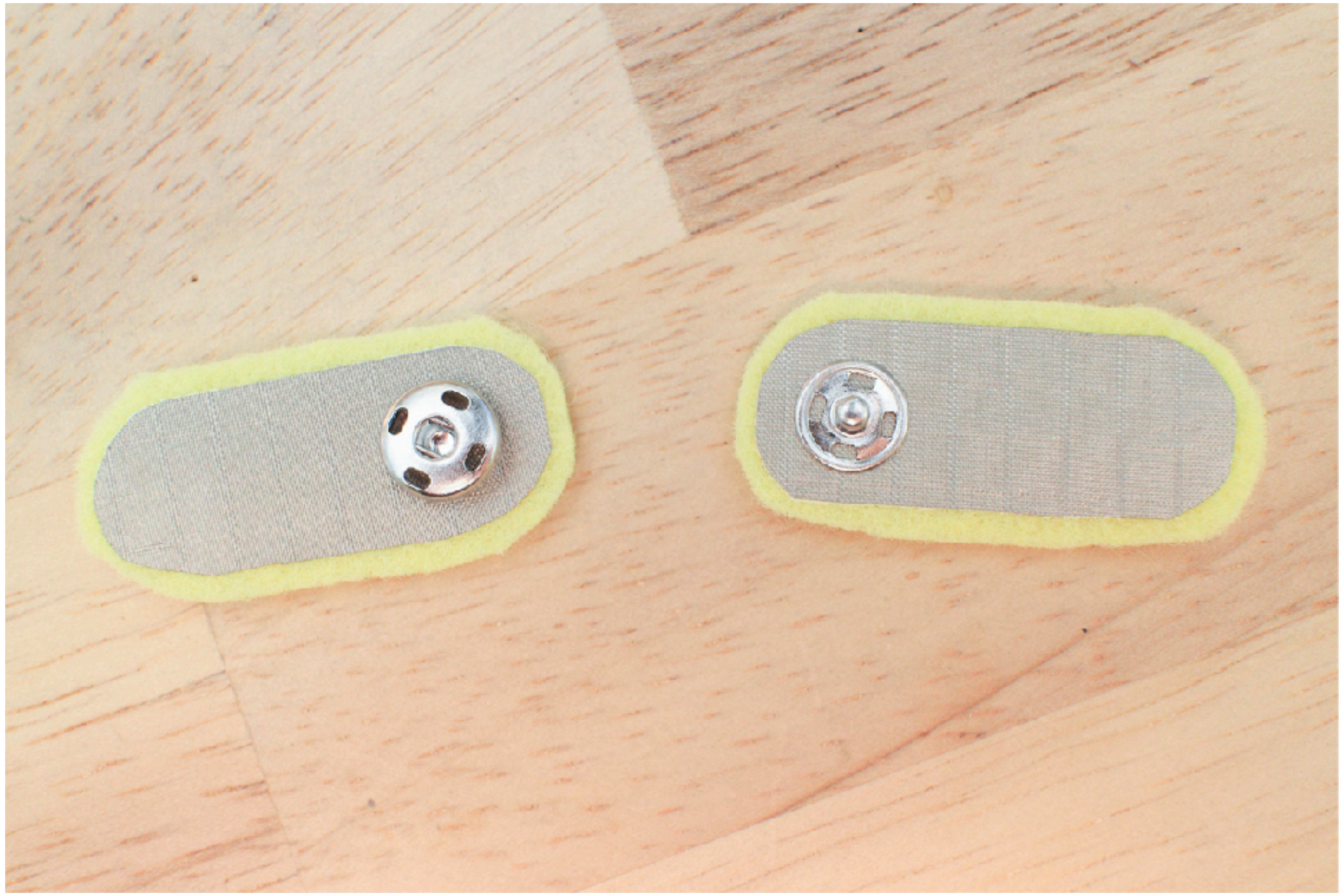
Tilt Switch / sensor

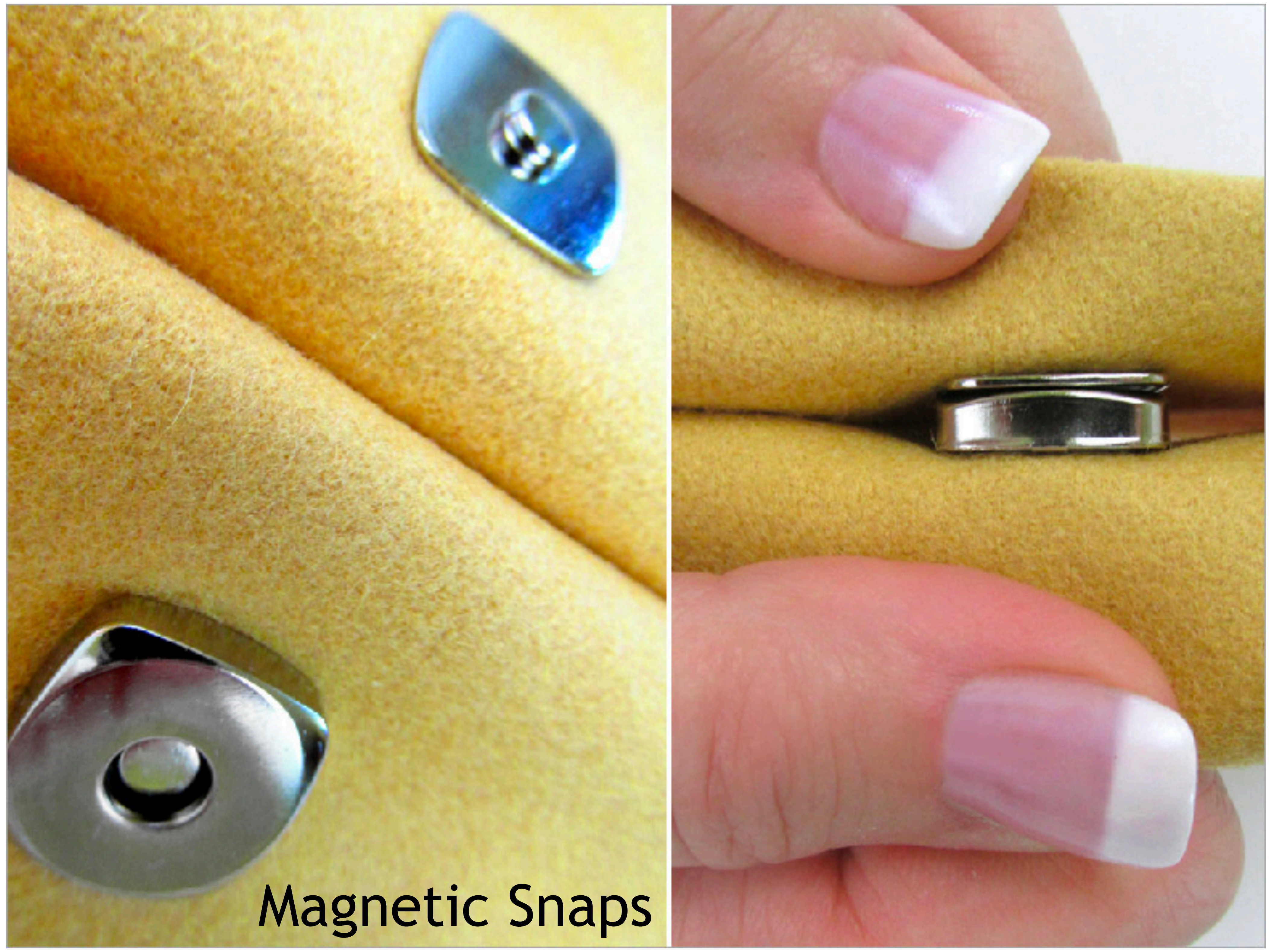
Moisture/ Conductivity Sensor

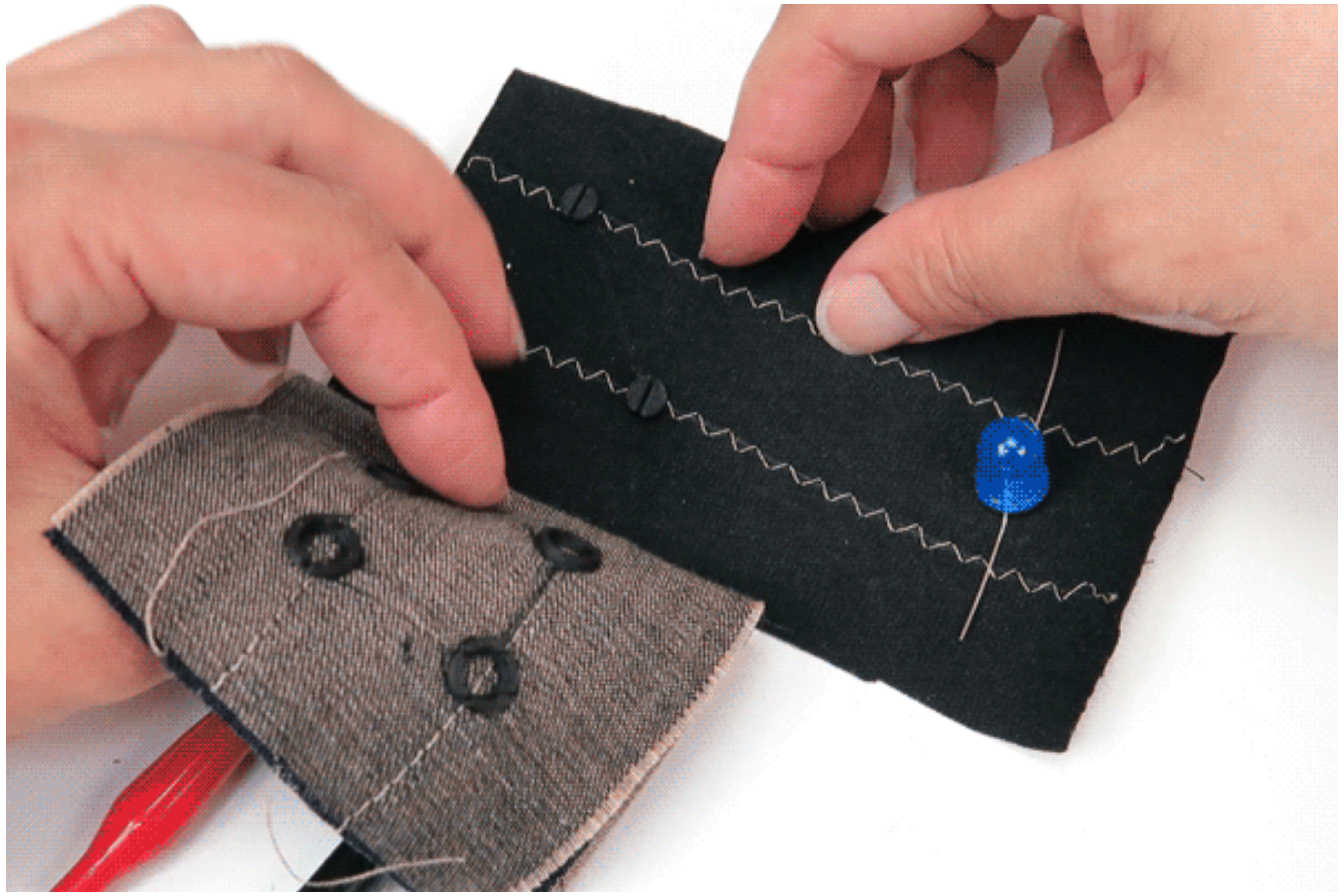


Soft Switches

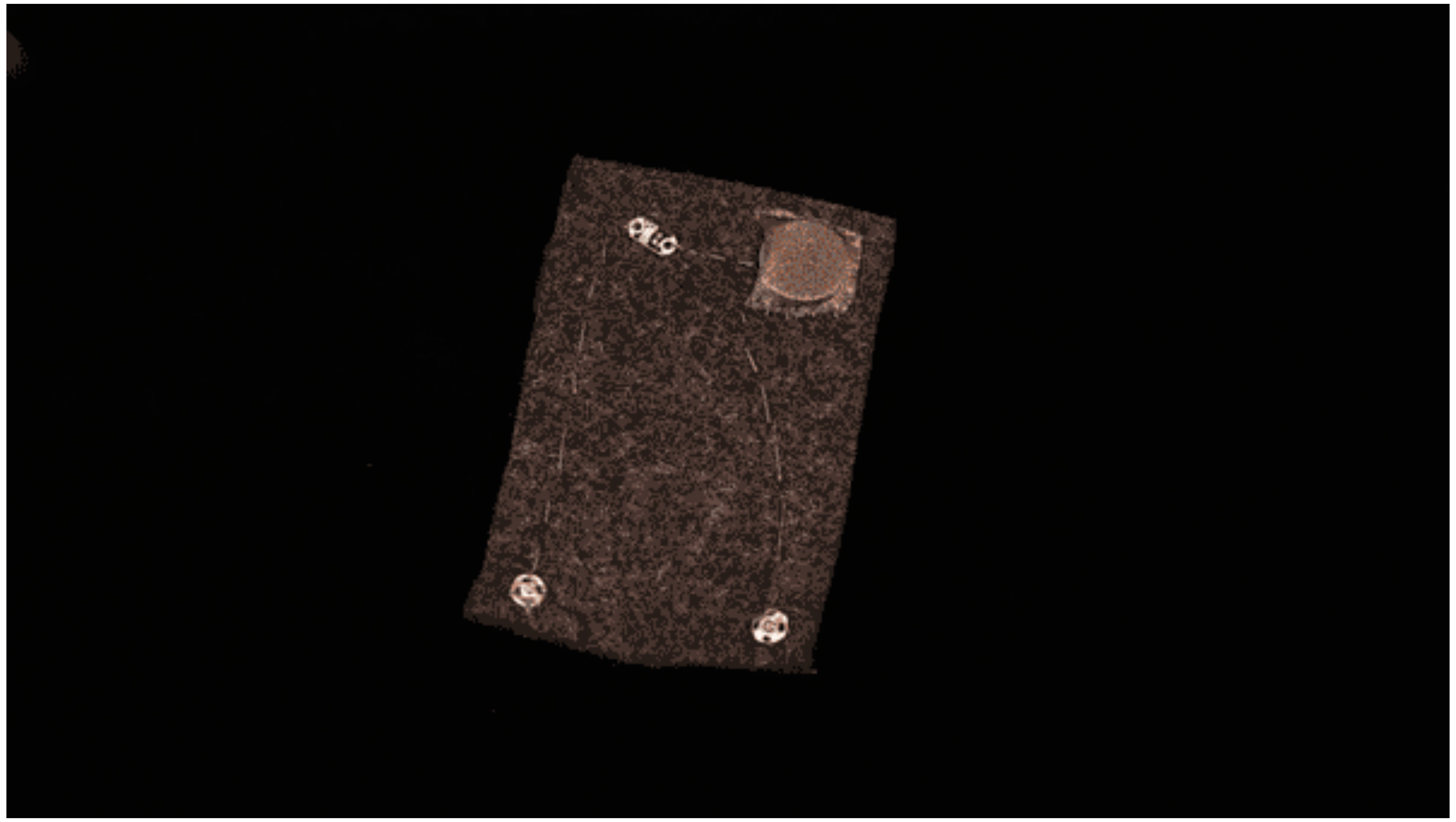


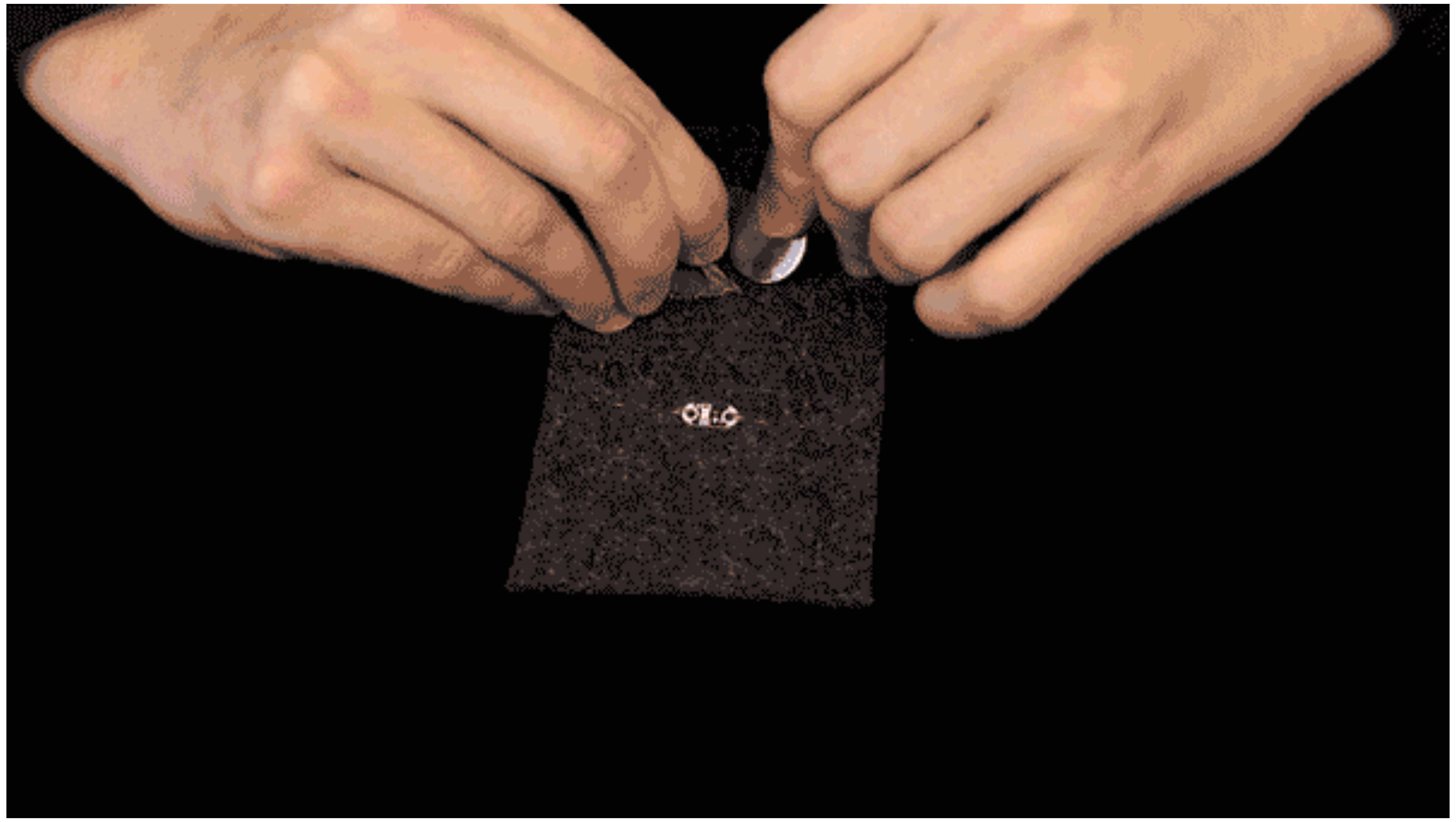



Magnetic Snaps

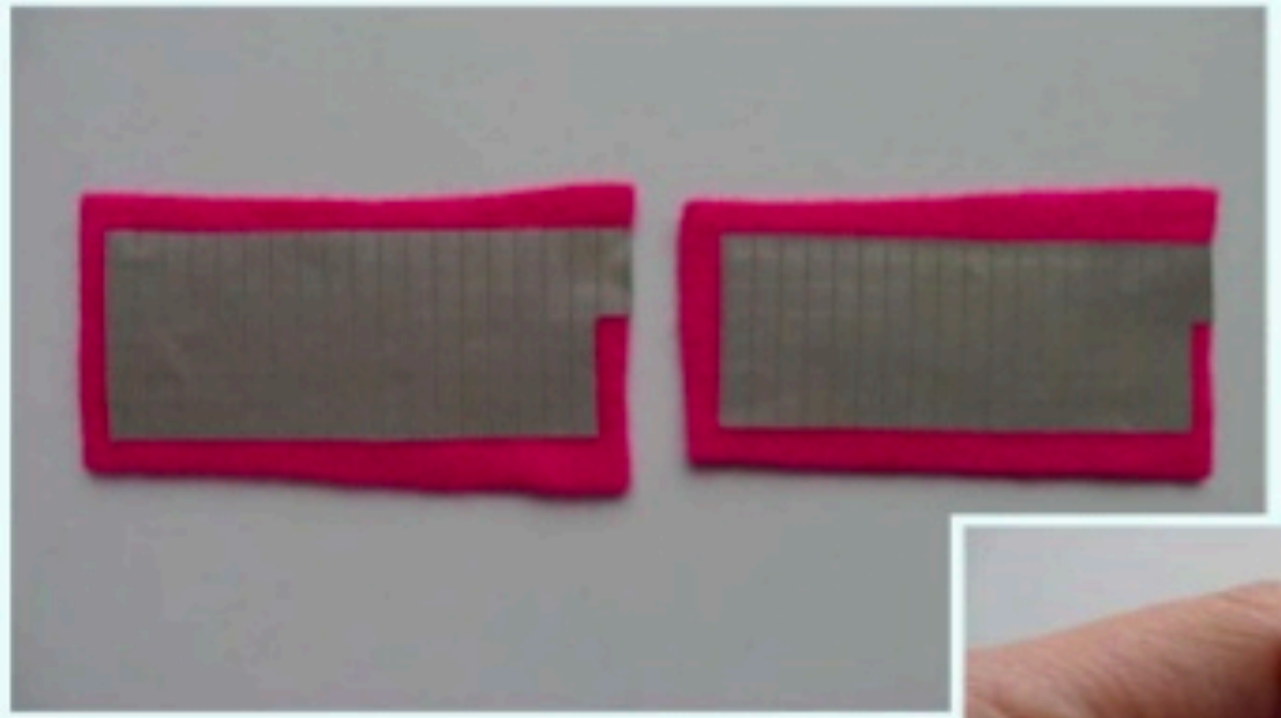


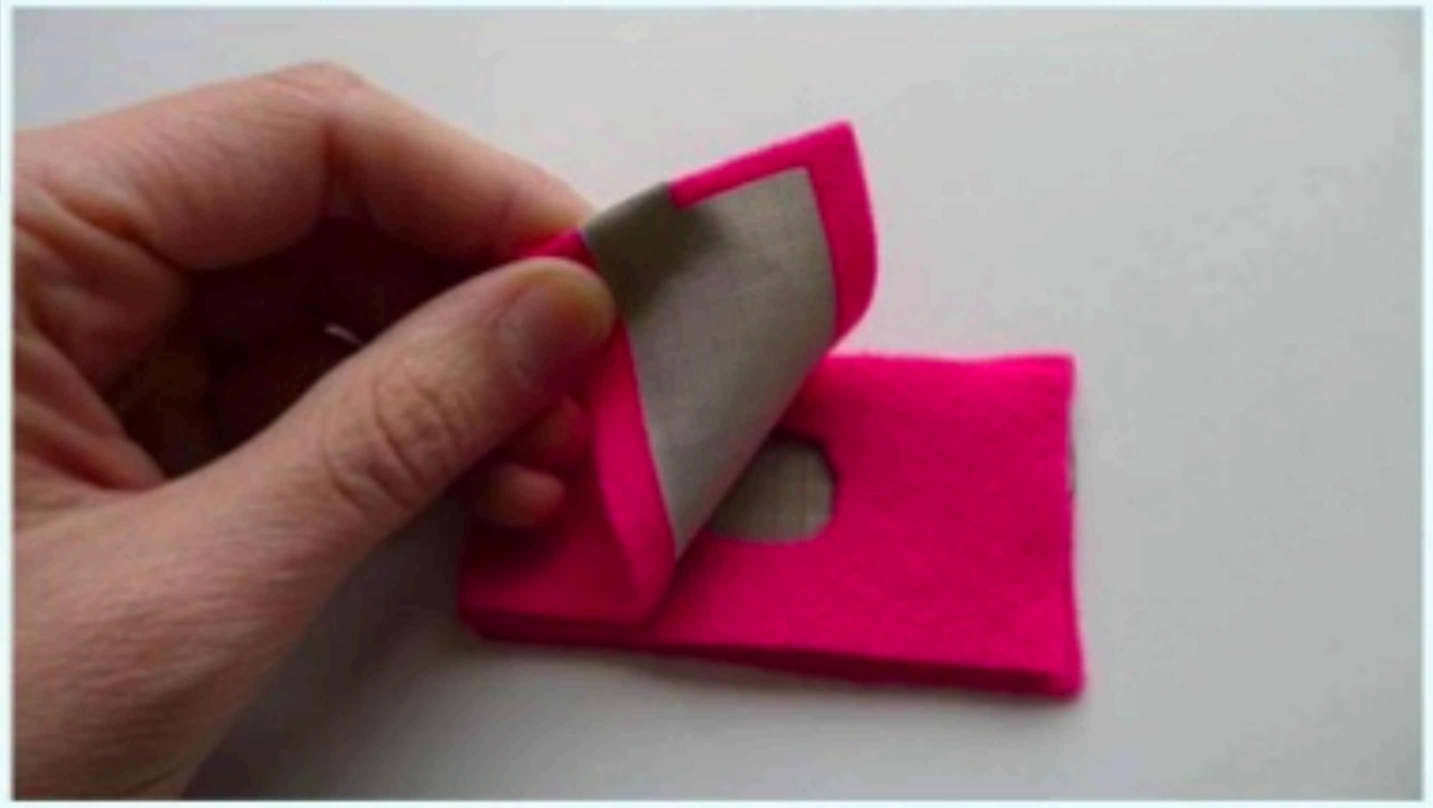
Conductive snap fabric tutorial



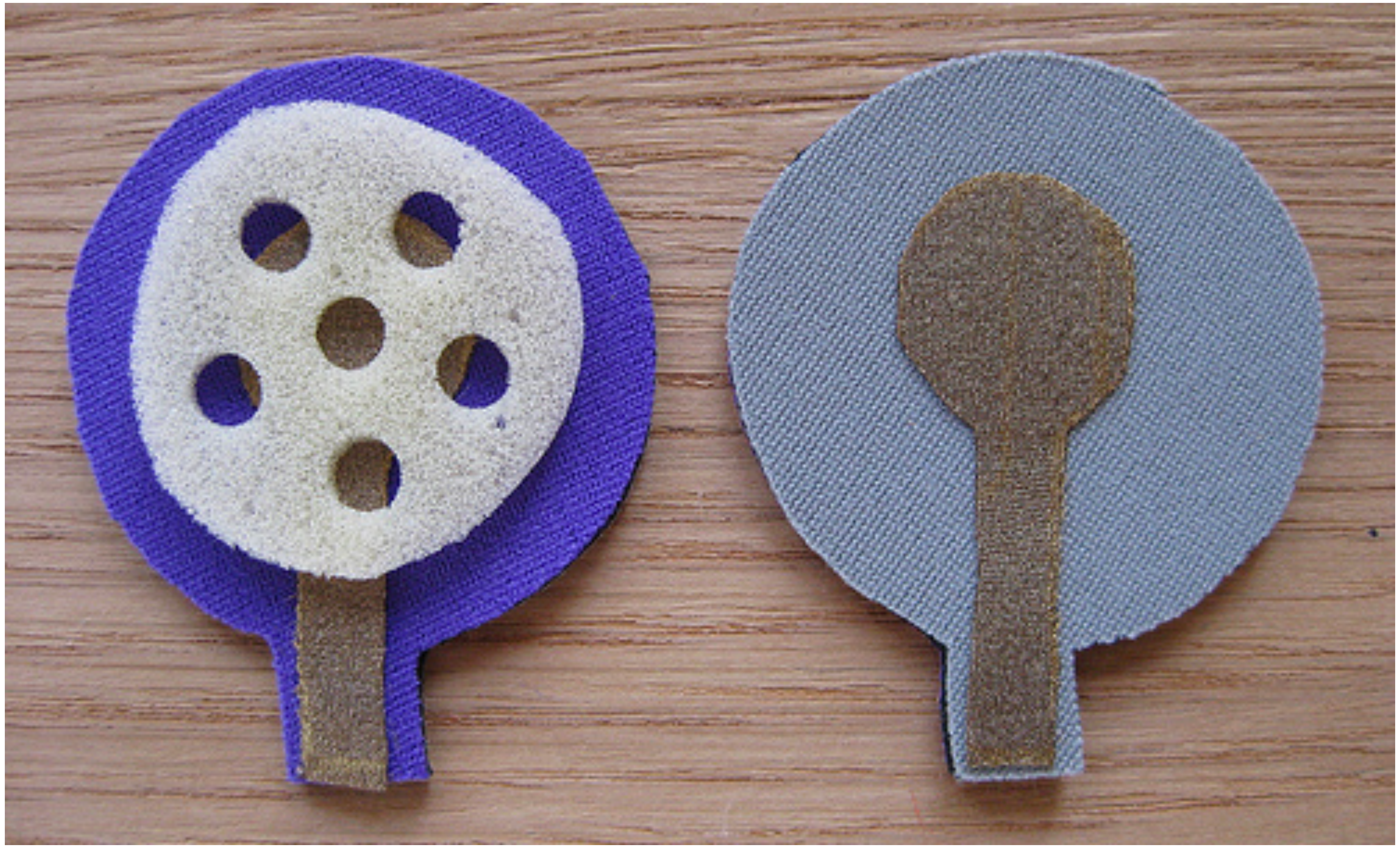


Build a fabric button

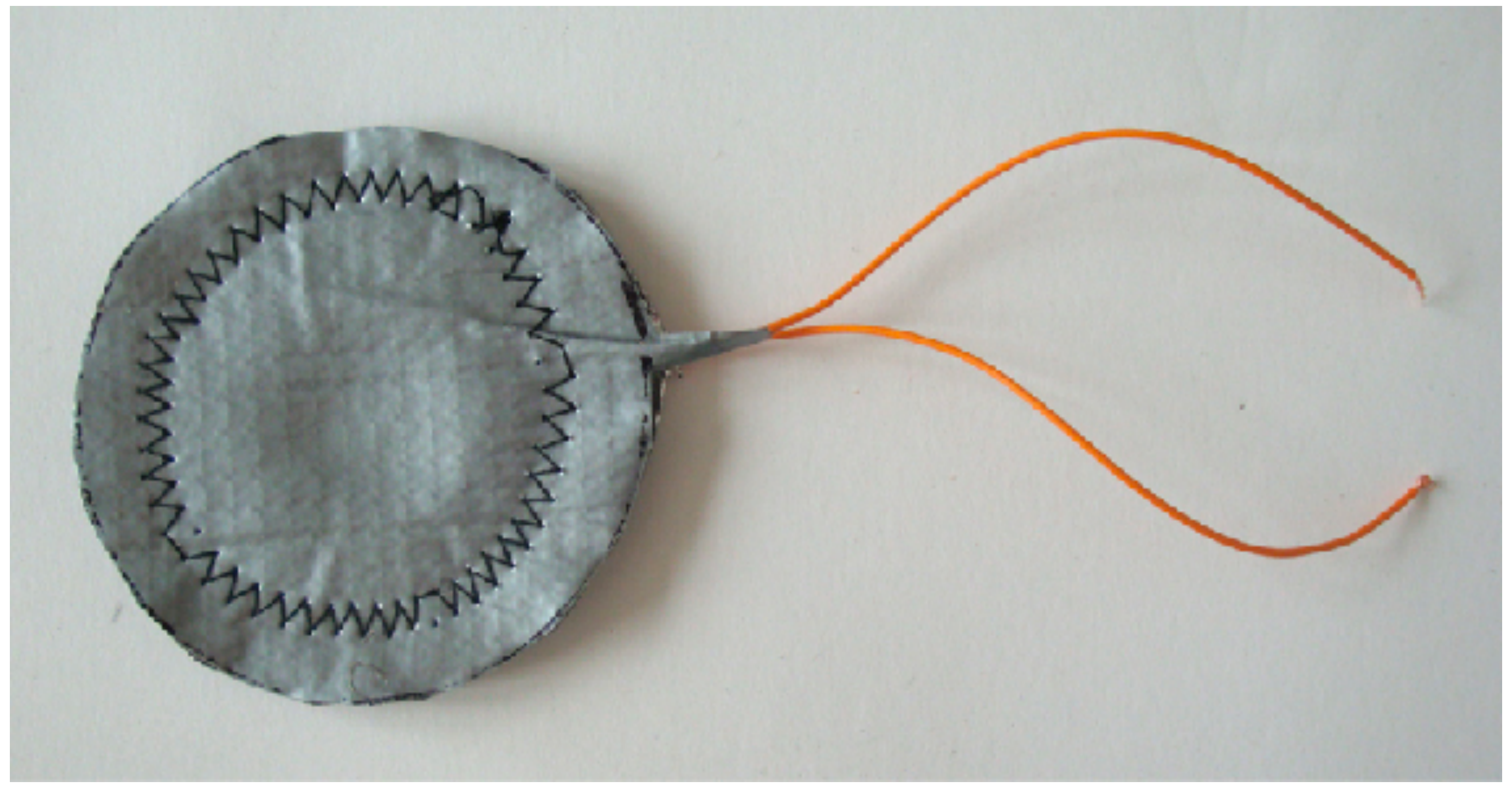




https://www.flickr.com/photos/plusea/3173880058



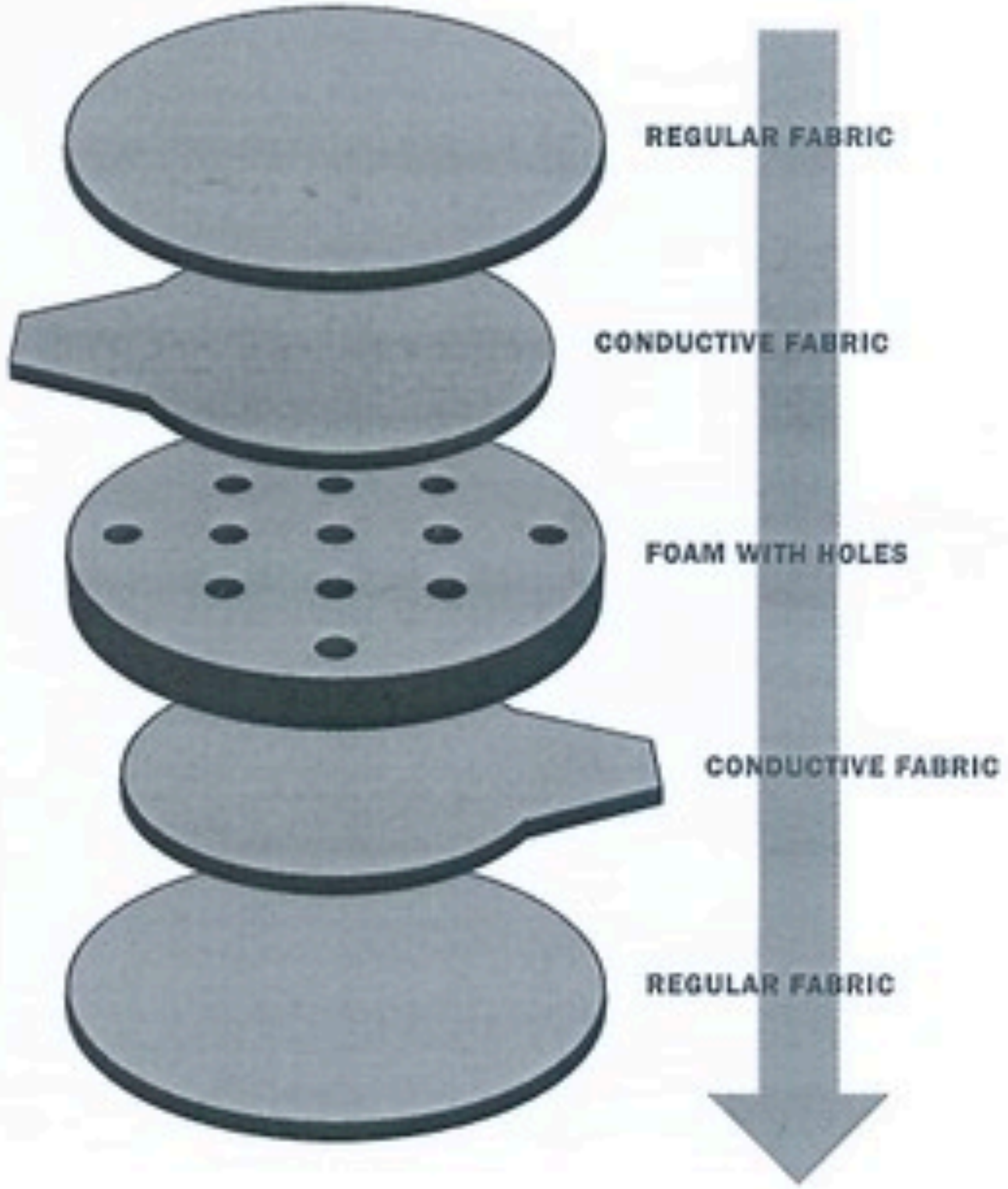
Soft button



TUTORIAL 1. SOFT SWITCH

1. Take the fabric pieces of your kit that are shown in the drawing. Place them in the correct order.
2. Take a multimeter and turn the dial to the setting that makes a noise when a connection is made. You know you've found the right setting when the multimeter squeaks when the metal parts of the red and black probe touch each other. Now place the probes of the multimeter on the two pieces of conductive fabric that stick out on either side. Now you are ready to test the soft button. If all is well you should only hear a noise from your multimeter when you push down on the button.
3. Now that you know your button works, sew all the layers together with regular thread.
4. Your soft switch is now ready to be used in a circuit. Look at the variation tip at the end of the led circuit tutorial if you want to use your button in this circuit.

Variation tip:
If you use Velostat (a black plastic) instead of the foam with holes between your two layers of conductive fabric then the resulting button is a pressure-and-bending sensor.



http://v2.nl/files/2010/lab/dmy/tutorial_Page_1.jpg/view

https://learn.sparkfun.com/tutorials/ldk-experiment-4-make-your-own-button

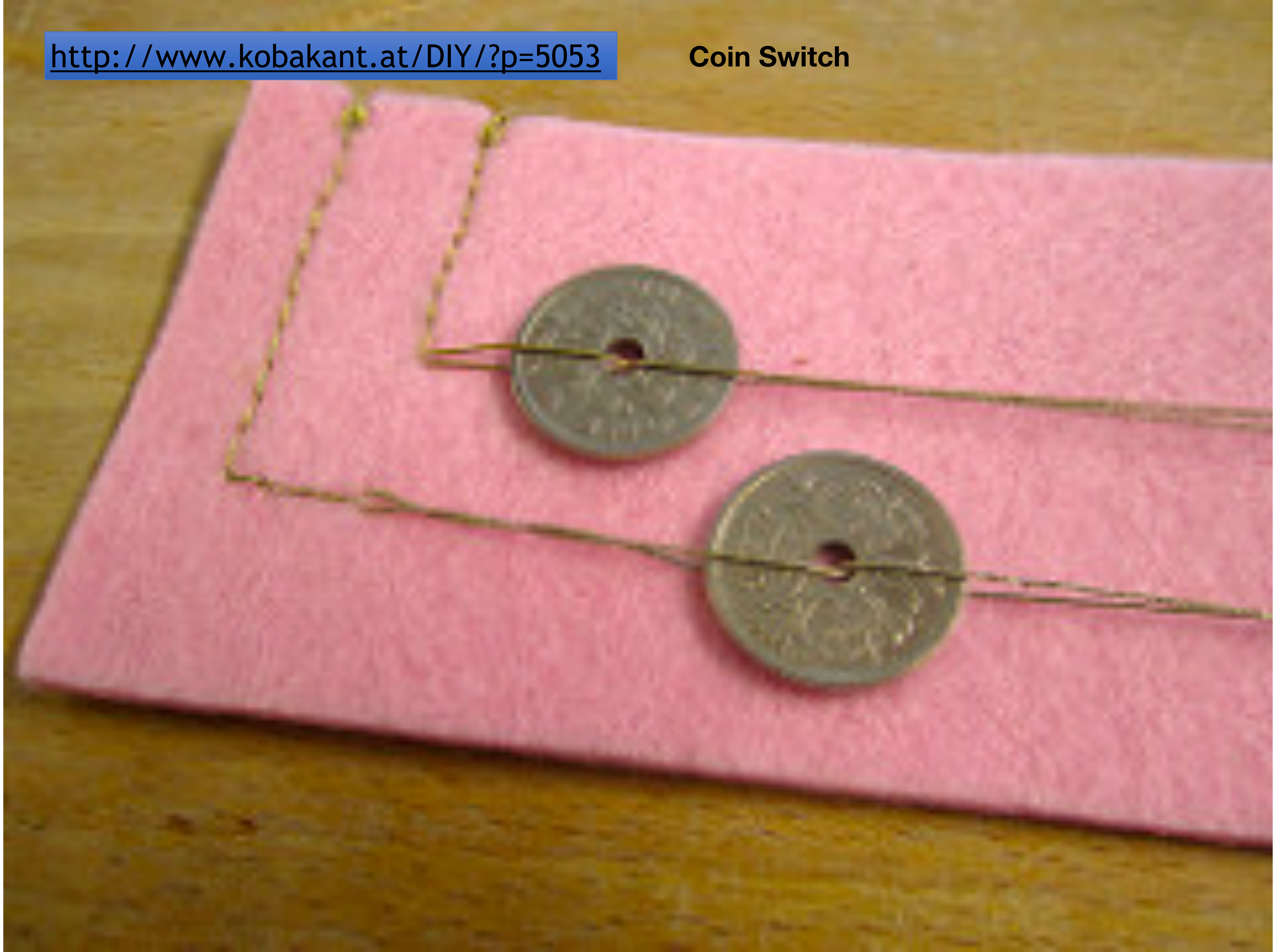

Finger Tap sensor
http://www.kobakant.at/DIY/?p=6706

Wimper Switch

http://www.kobakant.at/DIY/?p=5495

http://www.kobakant.at/DIY/?p=5053

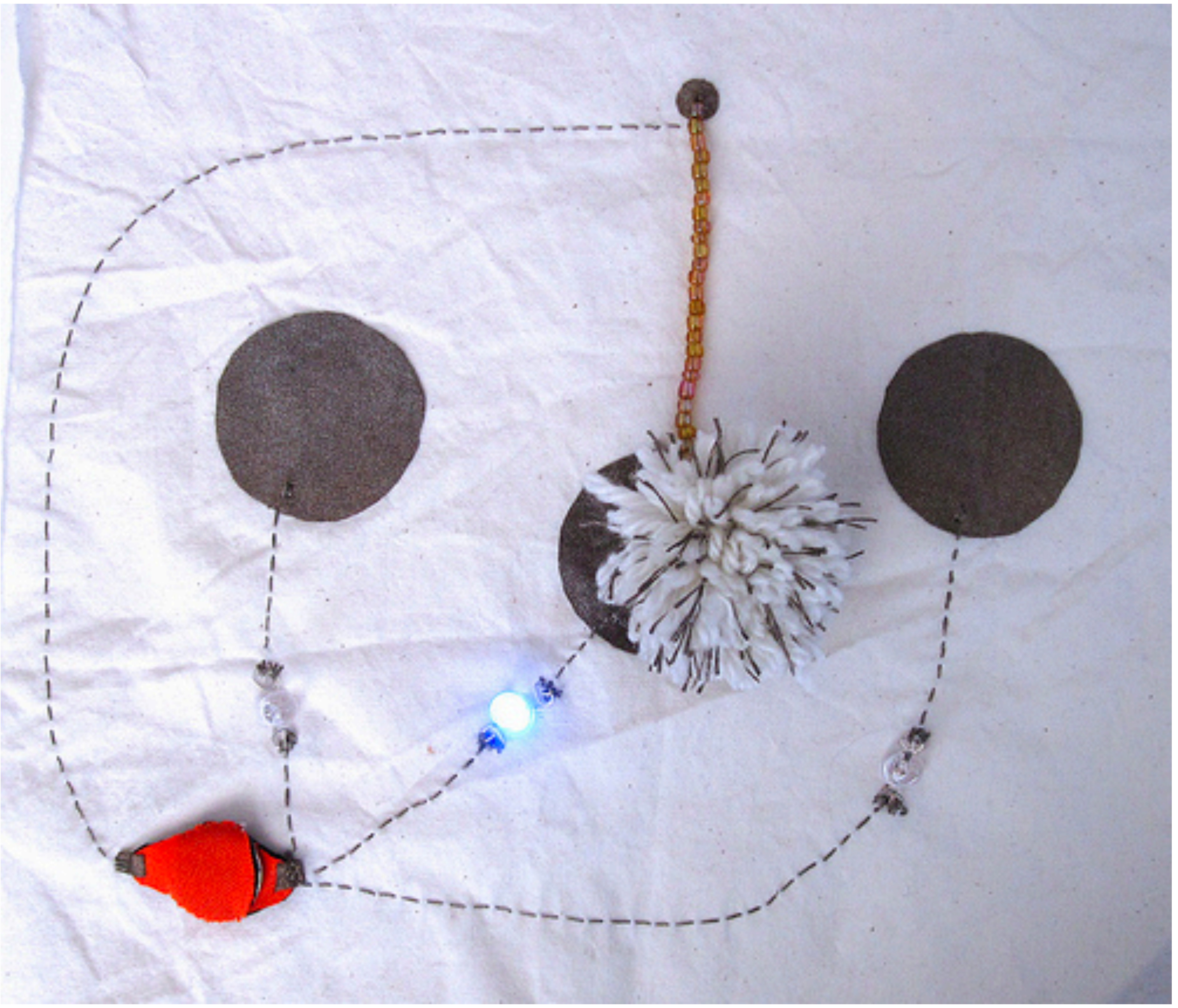
Coin Switch



http://www.kobakant.at/DIY/?p=2620 **Zipper Switch**

http://www.kobakant.at/DIY/?p=2409

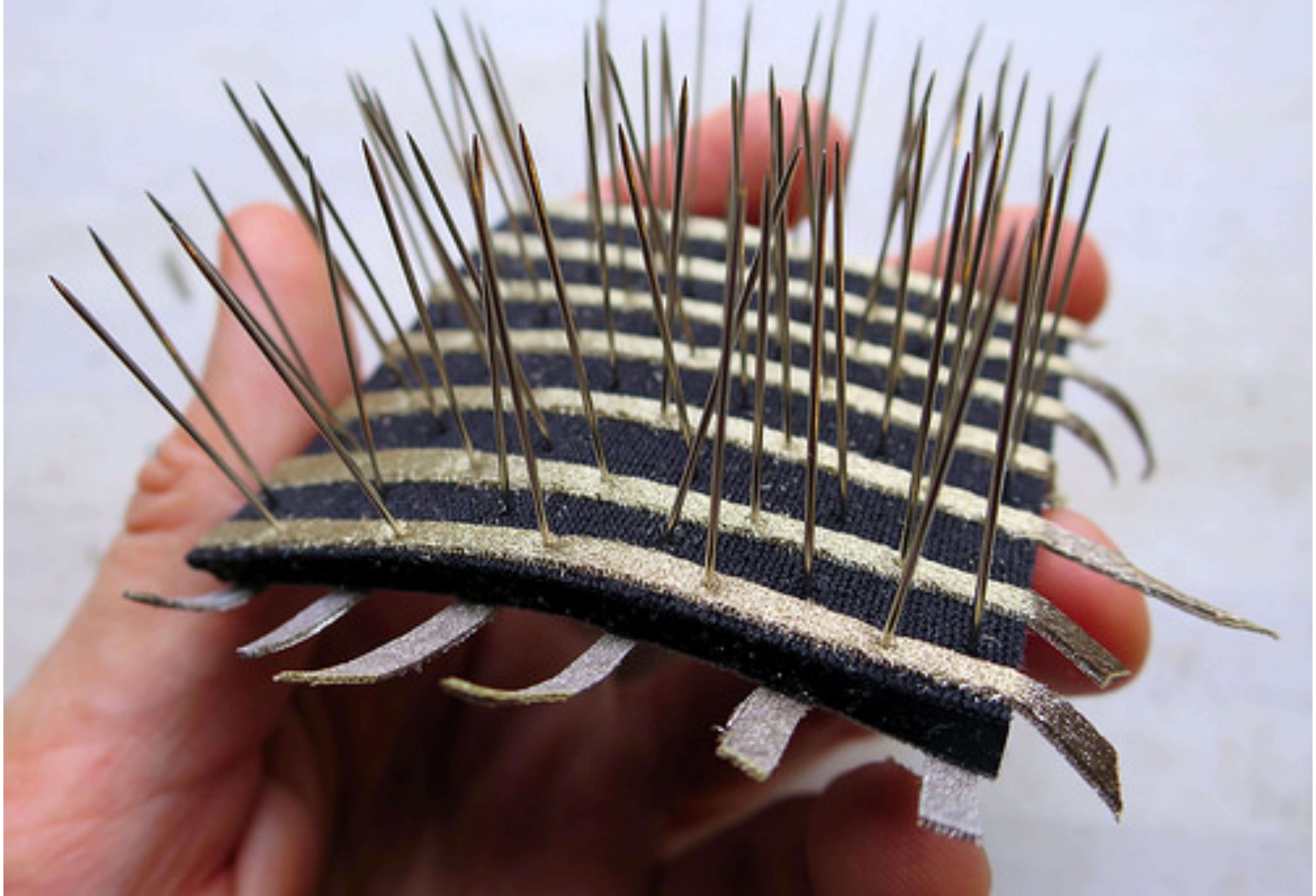
Pompom Tilt

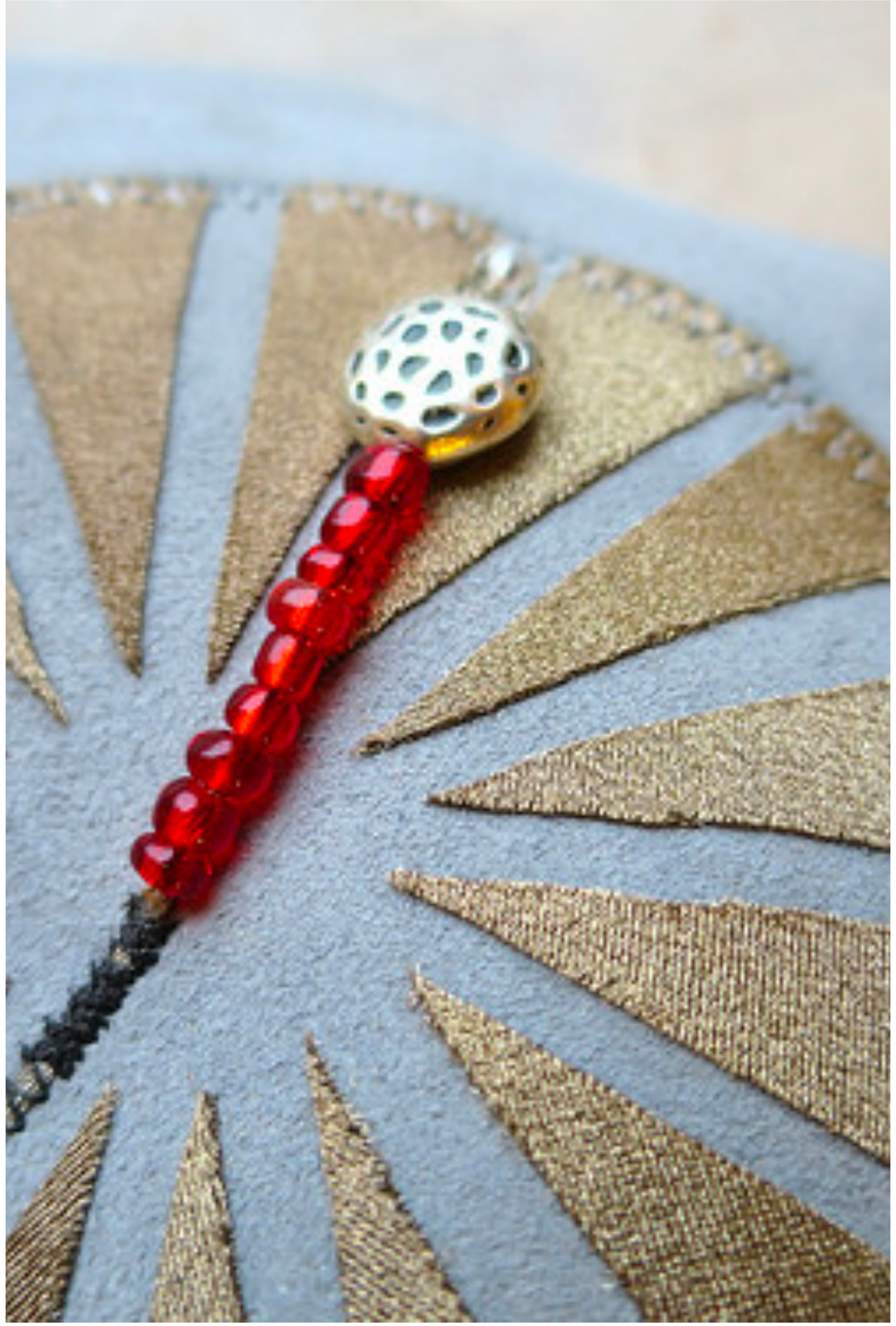


http://www.kobakant.at/DIY/?p=4317

http://www.kobakant.at/DIY/?p=6237

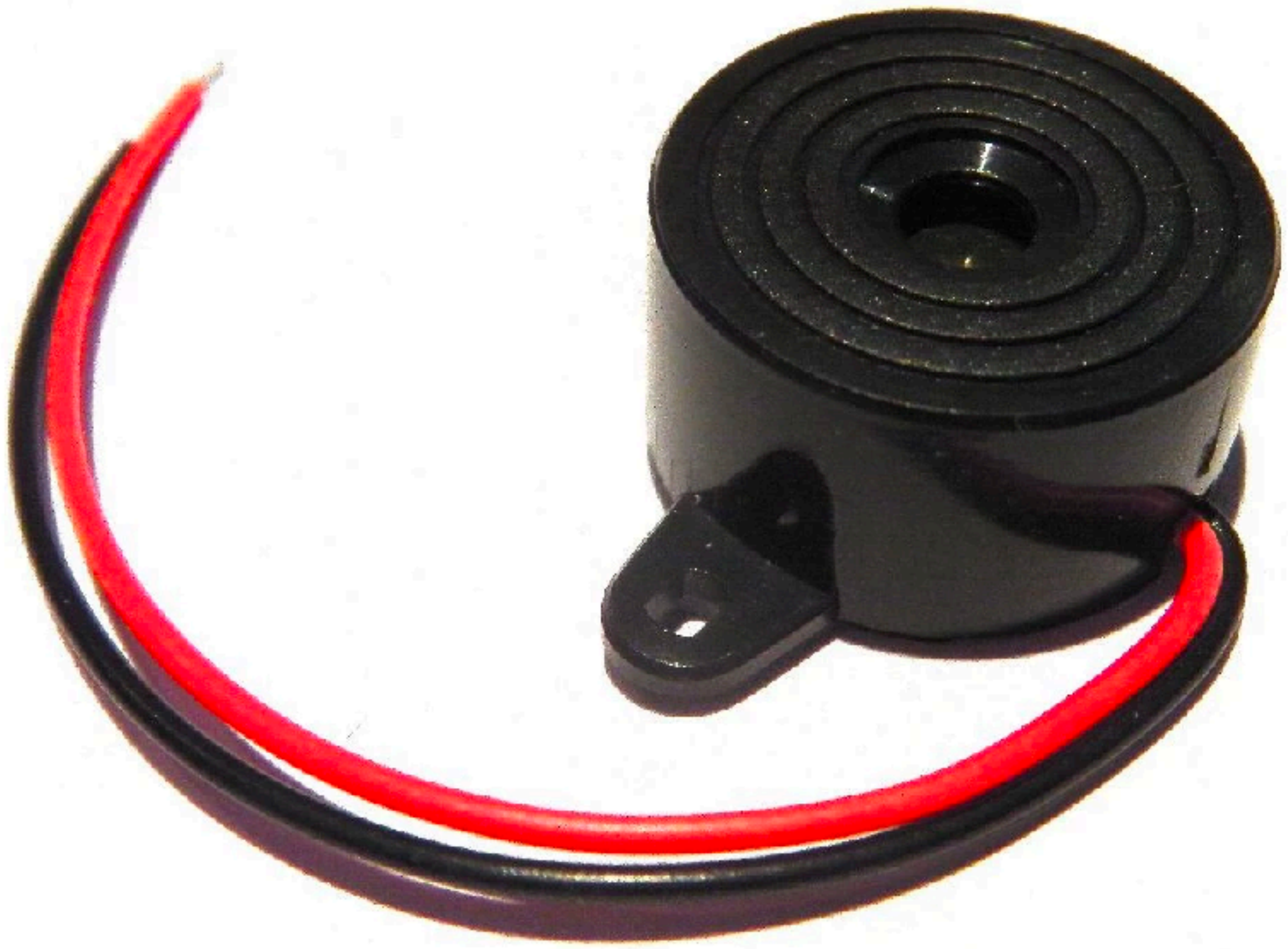
Stroke Sensor





https://www.kobakant.at/DIY/

Vibration Motor

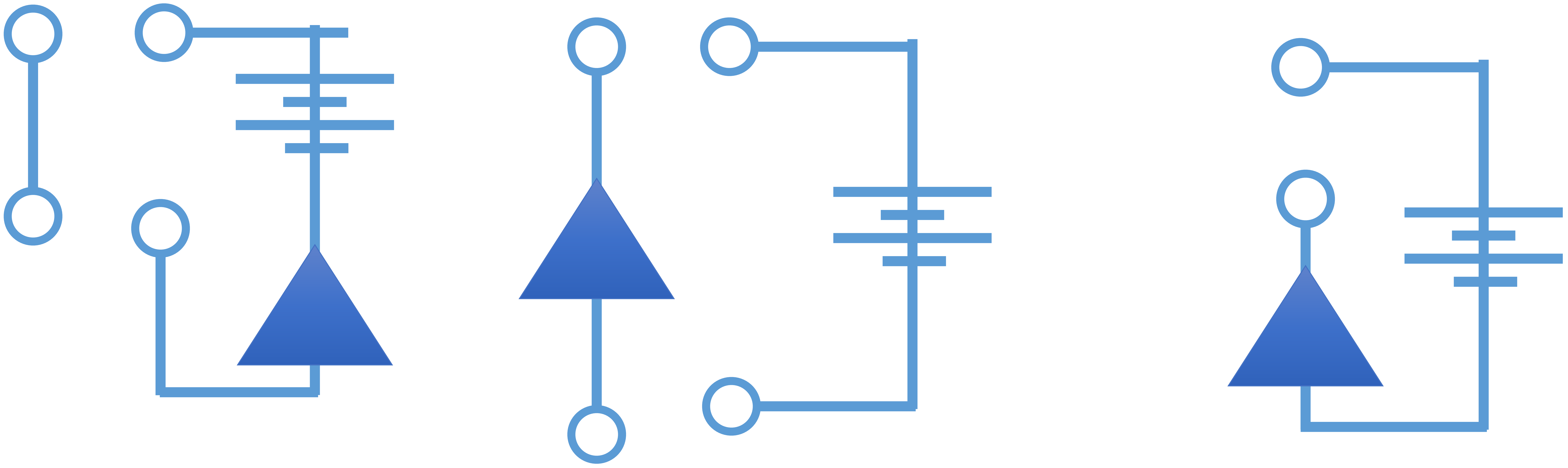


Buzzer

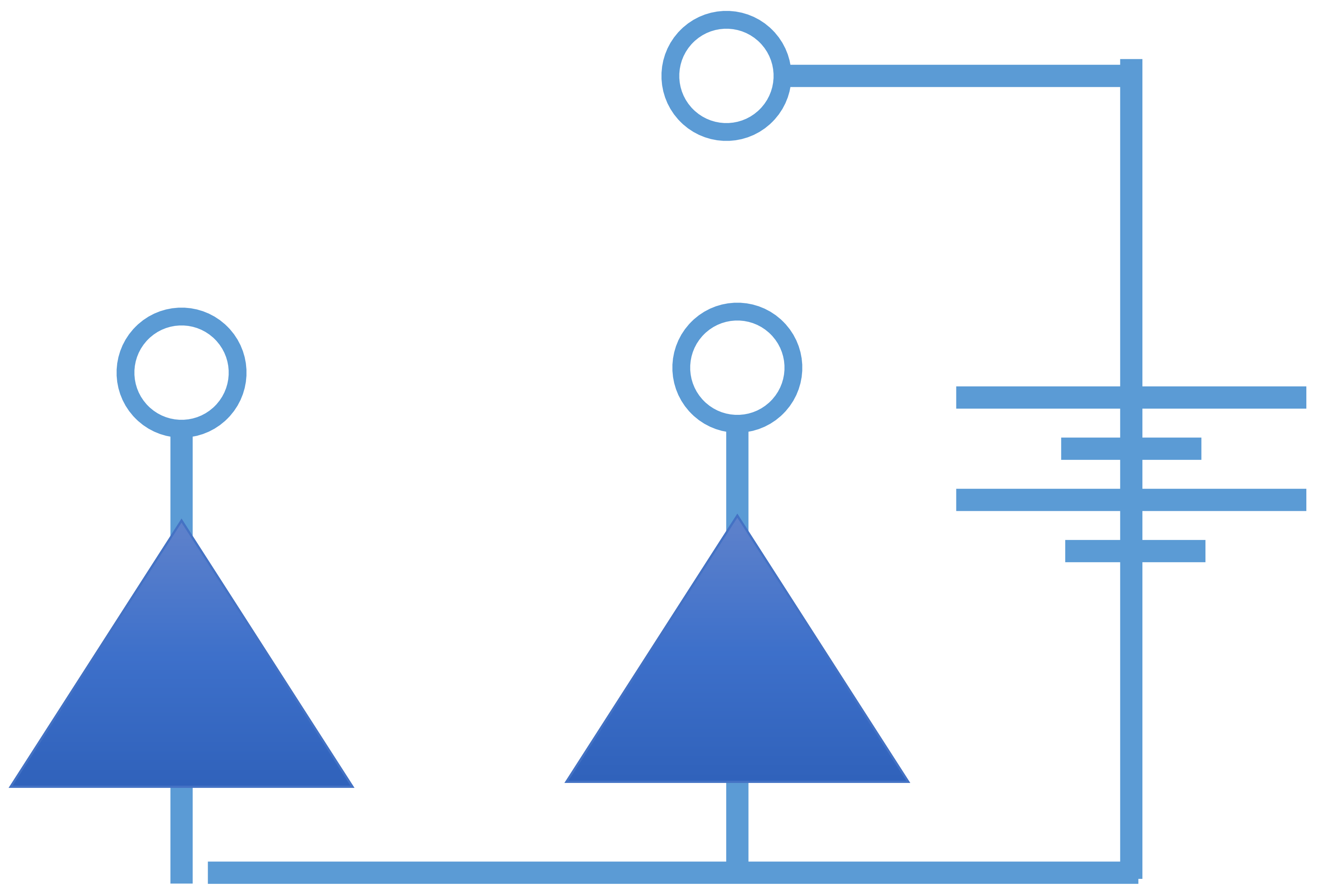
Switches On The Body

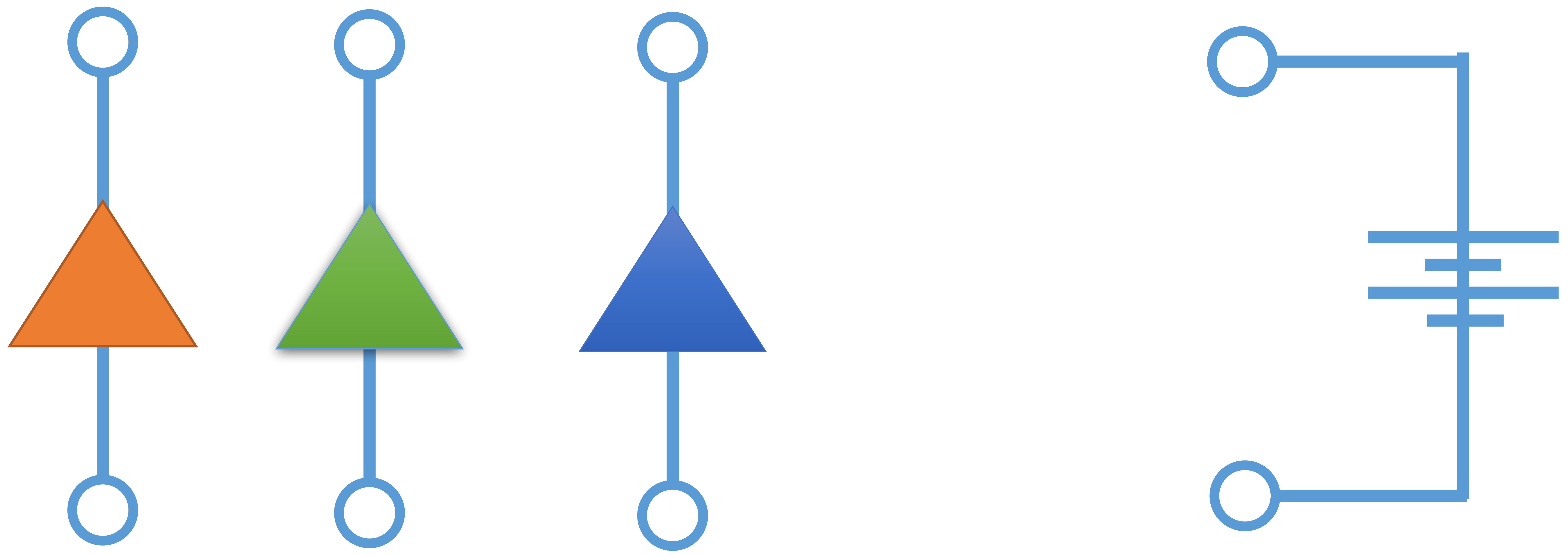

Collaborative
Sensing

SPST



SPDT





Debugging


the blinky lights are doing
weird shit again

If its not working...

Look for short circuits

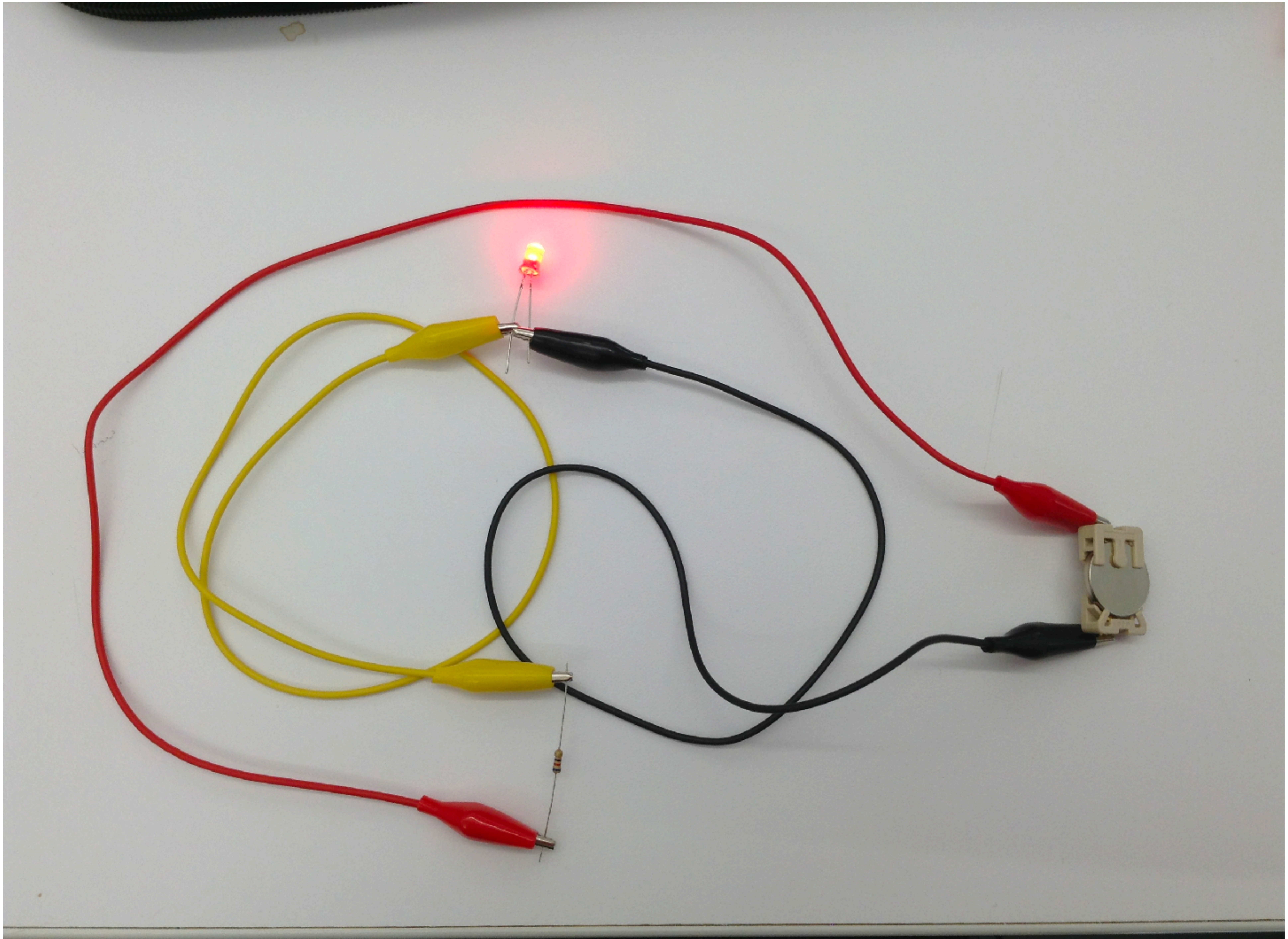
If any exposed part of your circuit is touching, the electricity will skip the load and go back to the battery.

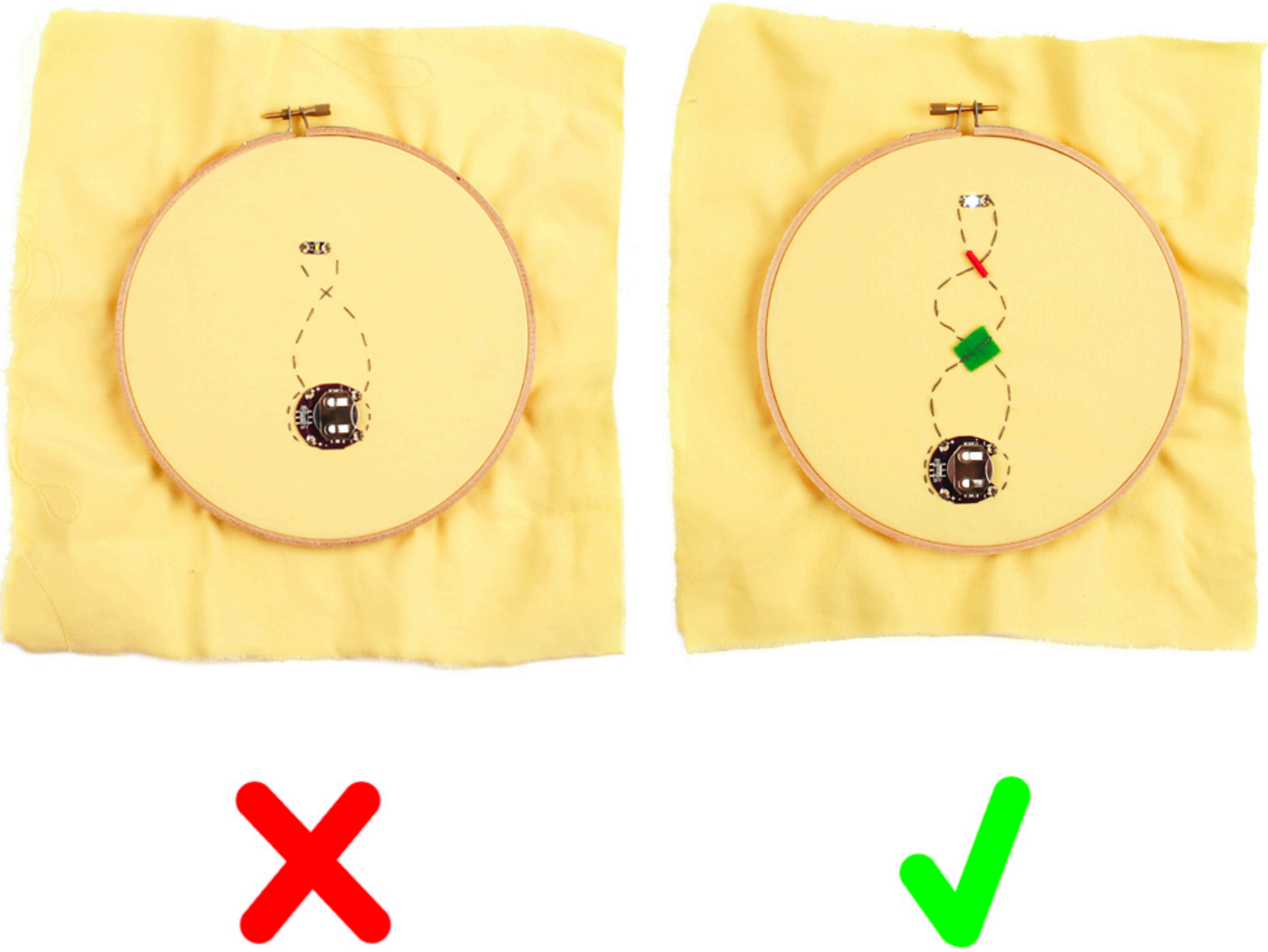
Check the battery

Try a new battery! If you've been using it a lot, or if your battery has been shorting, it might be dead.

Check the power consumption

Maybe your circuit is using too much power for the battery. You can do some basic math to calculate this.





Electricity is lazy, it will alway try and find the fastest way to get back to the battery and skip the circuit

Lets make some switches!

- Get in groups of 2-4

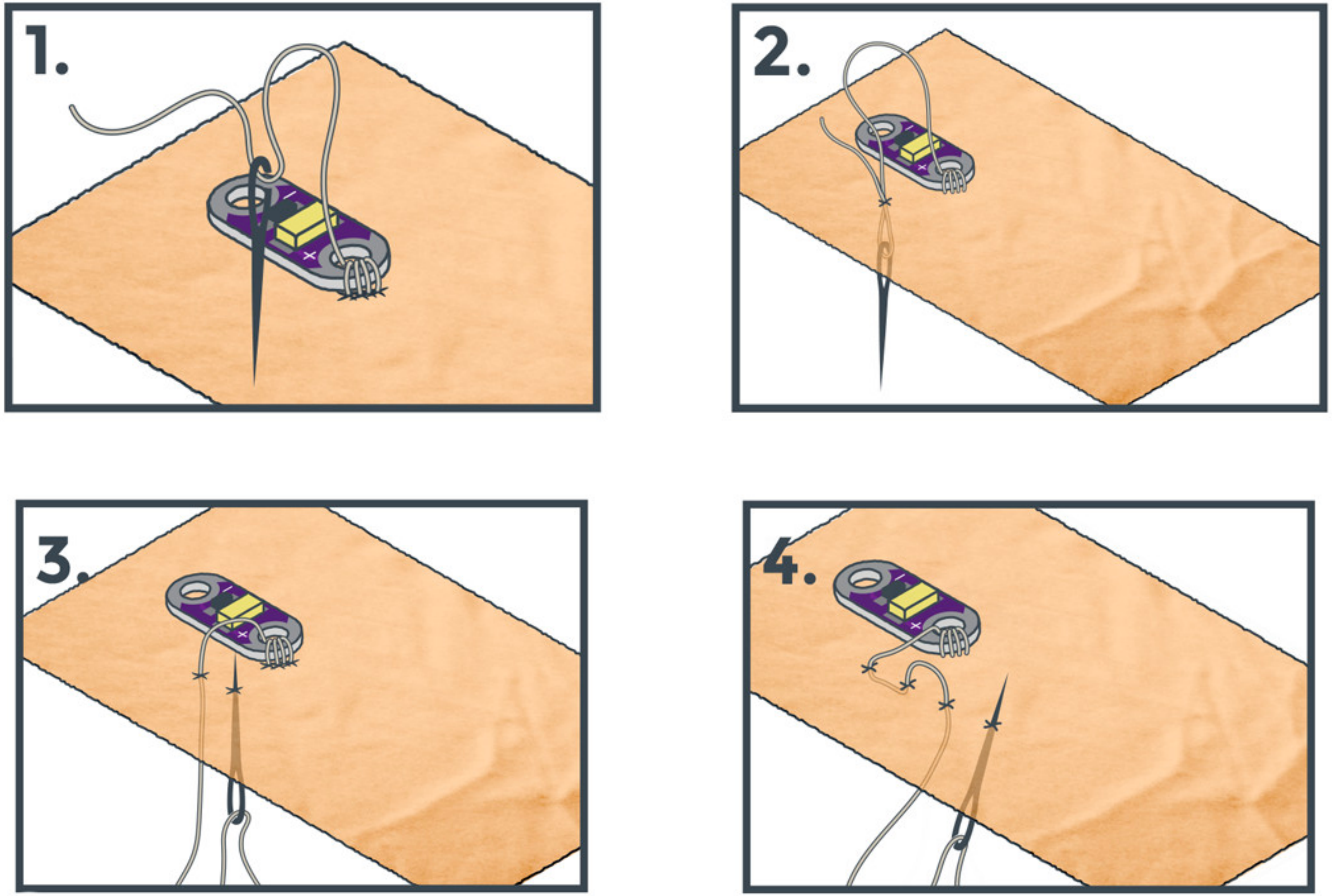
Make a switch that is on one body

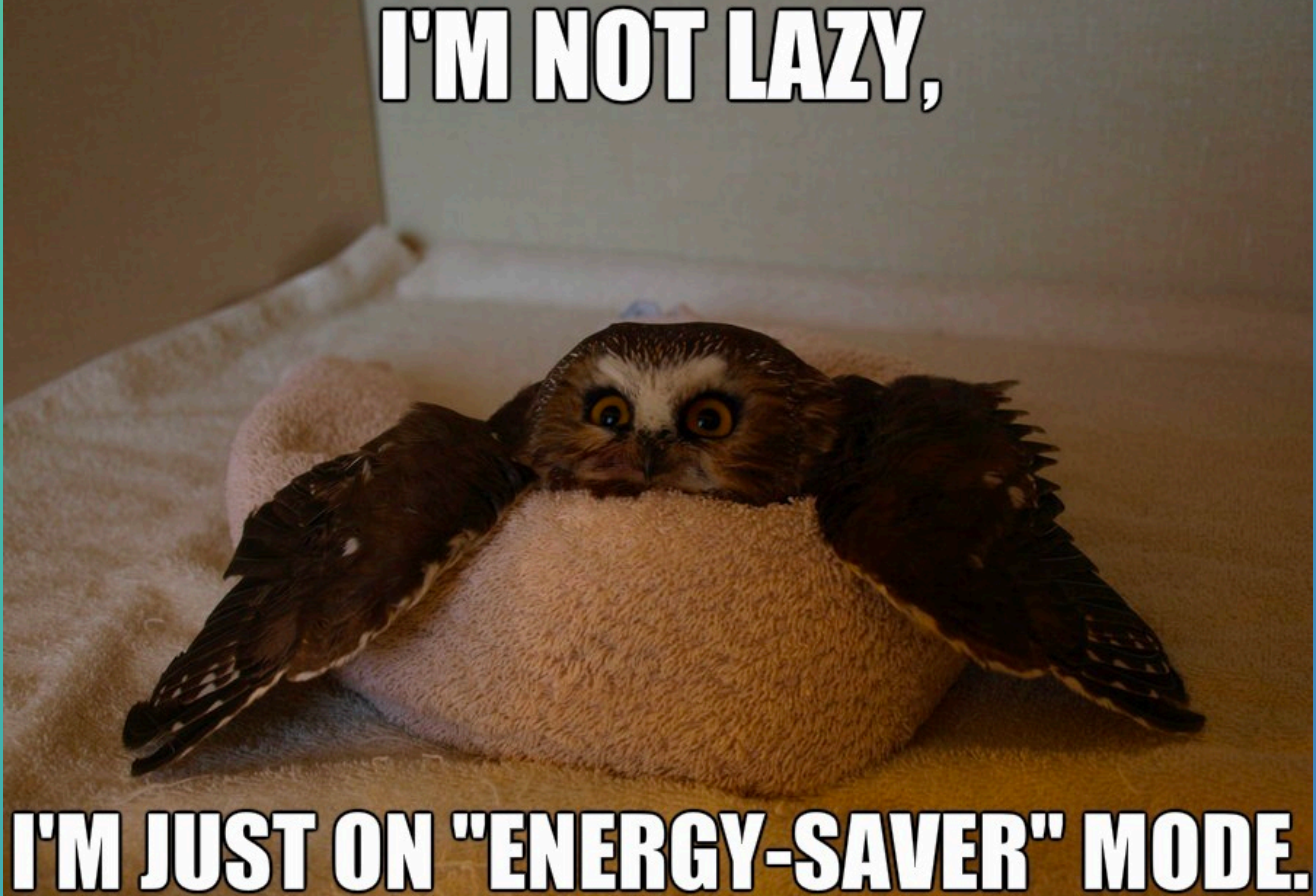
Make a switch that is between two people

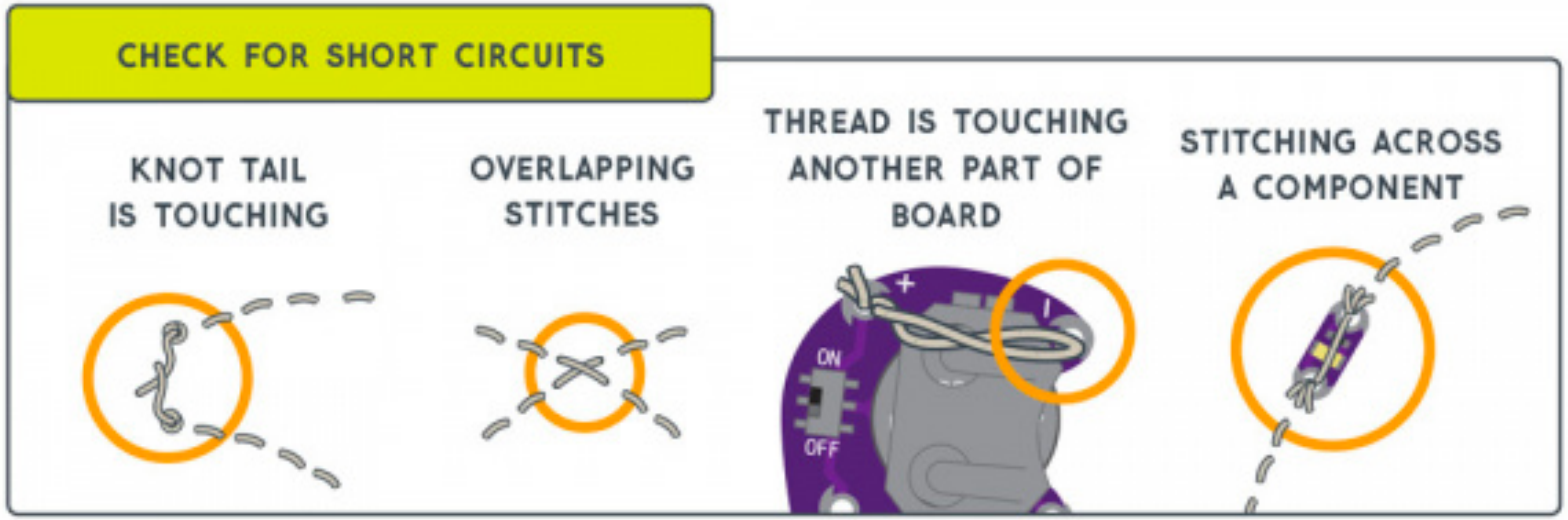
Make a switch that is between a body and an item in the environment

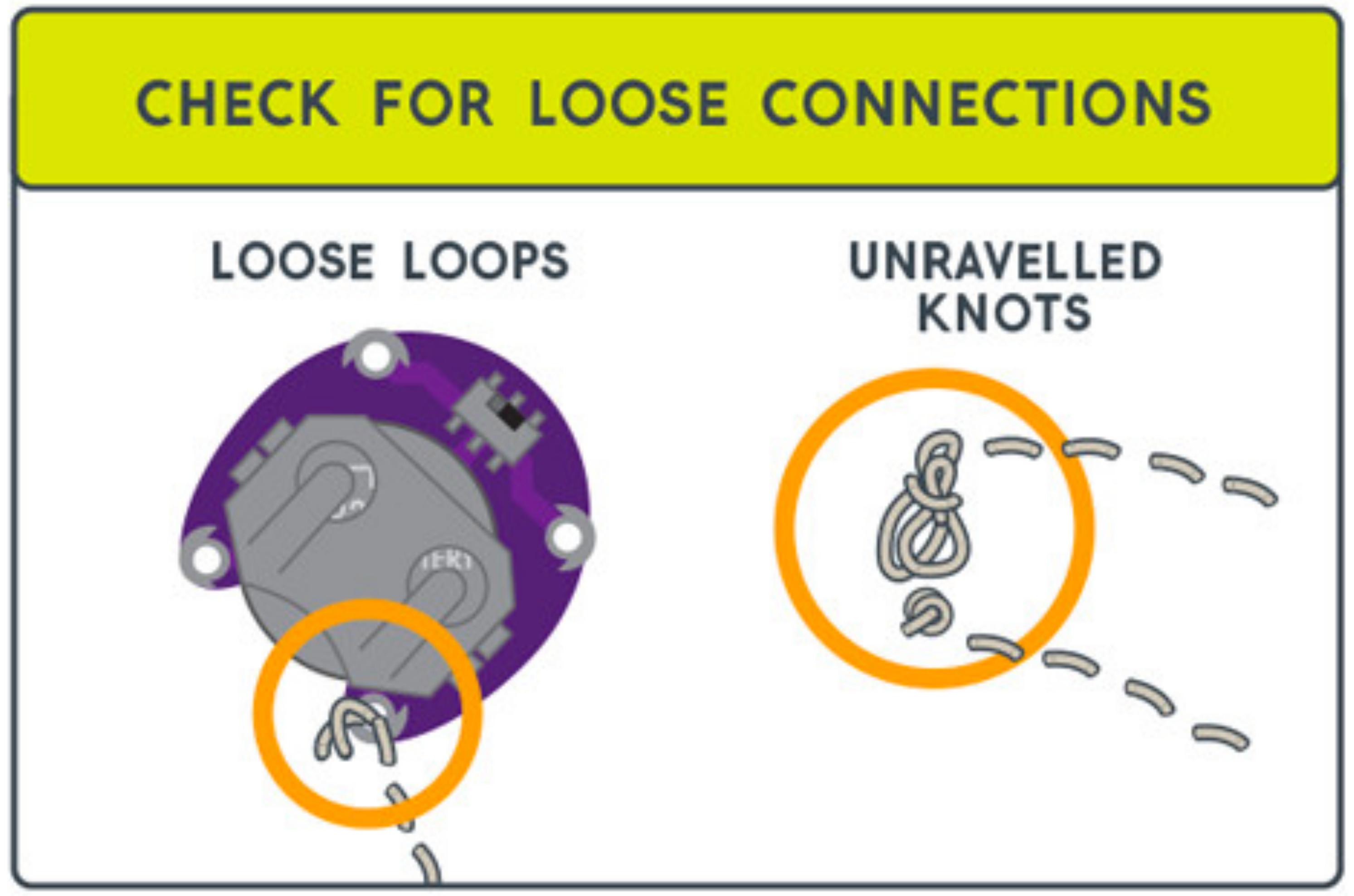
Always test your circuit before with
Alligator clips

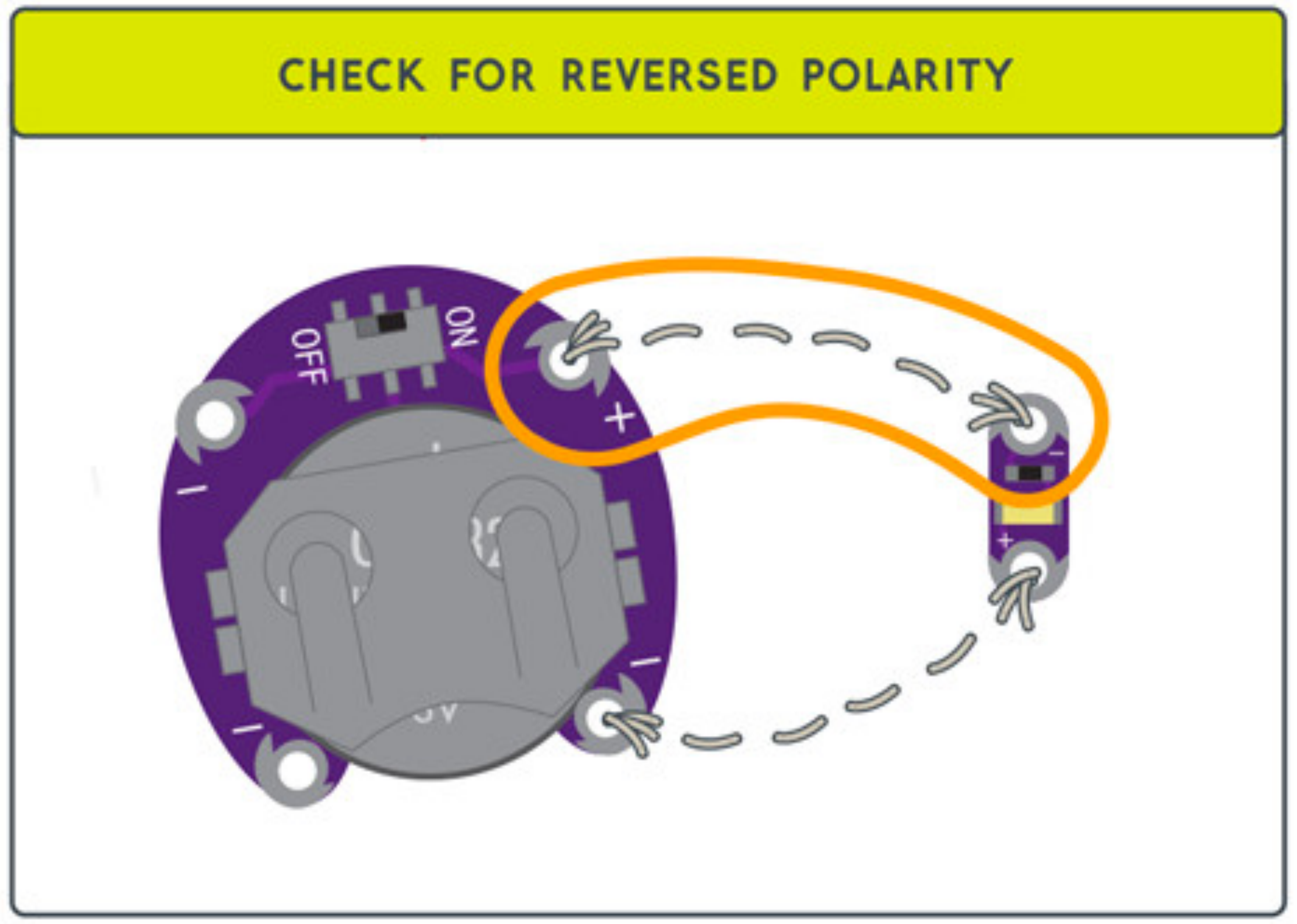
https://learn.sparkfun.com/tutorials/lilypad-basics-e-sewing/all

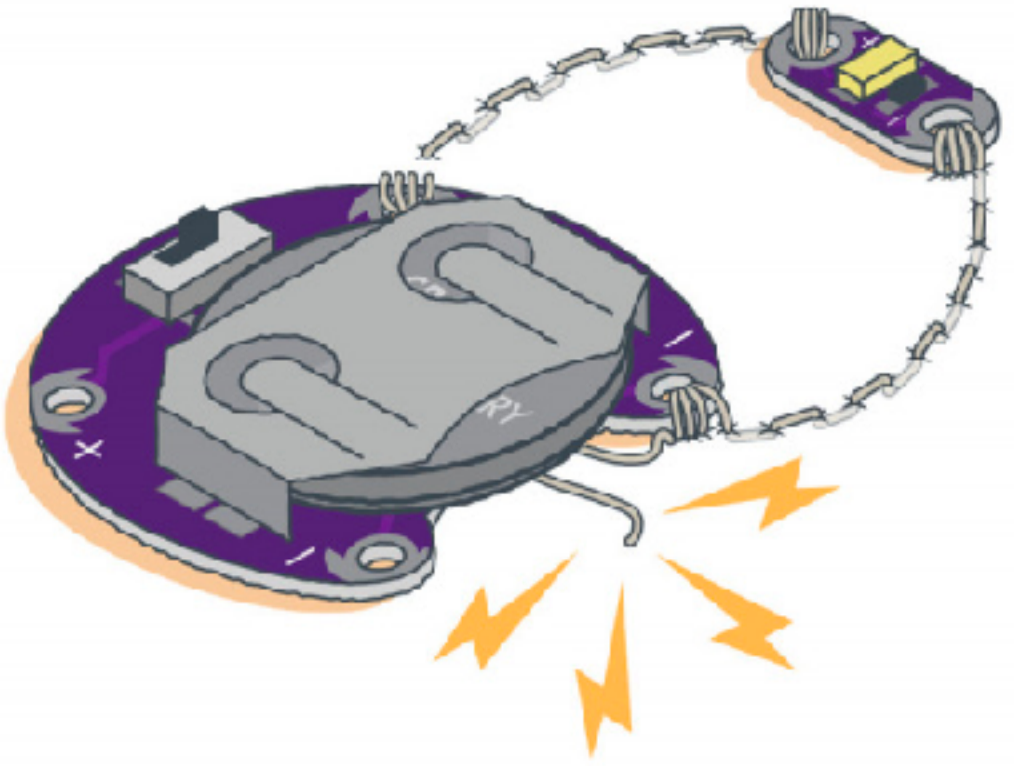

1.
2.
3.
4.

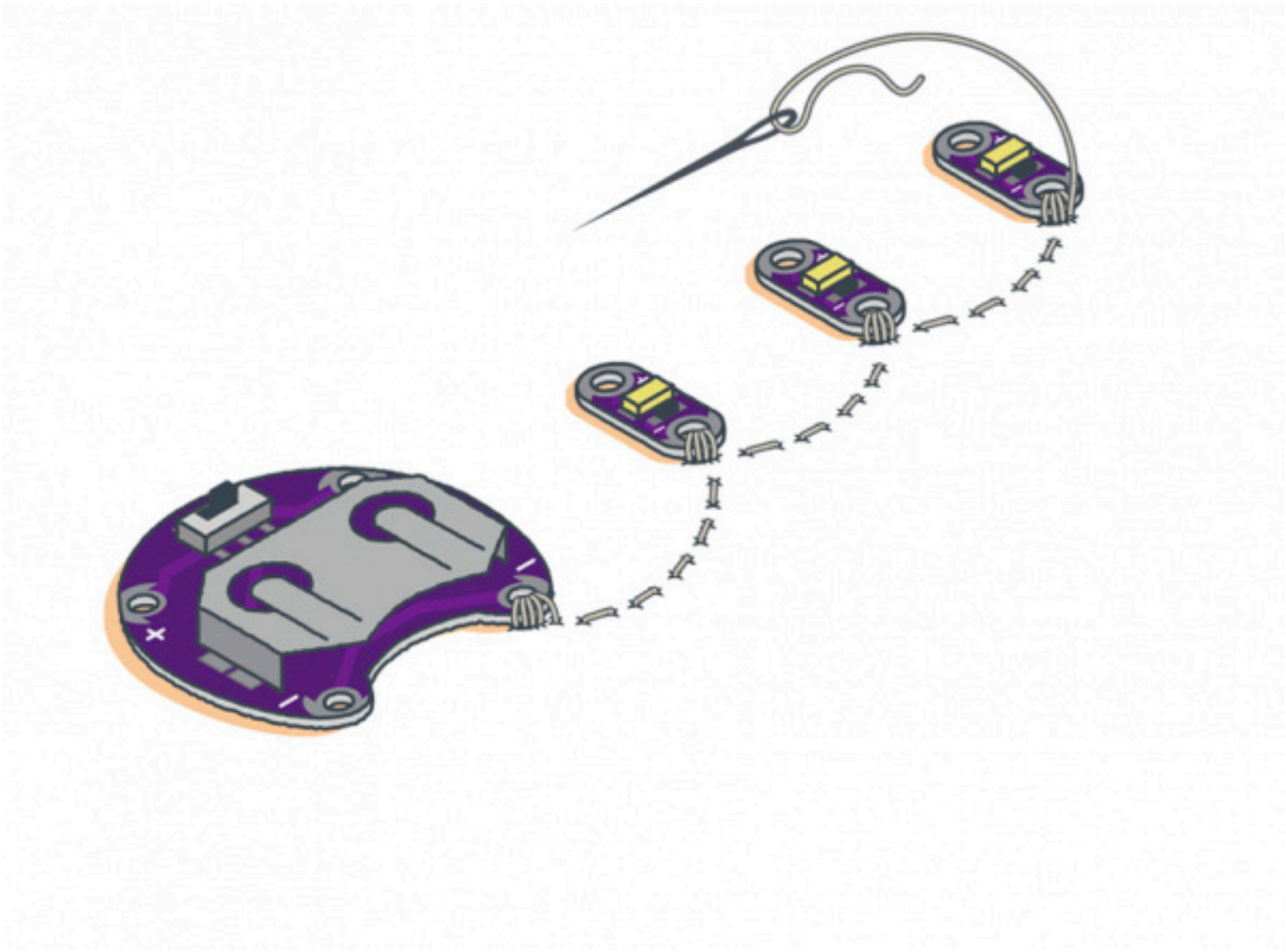

I'M NOT LAZY,
I'M JUST ON "ENERGY-SAVER" MODE.


CHECK FOR SHORT CIRCUITS
KNOT TAIL IS TOUCHING
OVERLAPPING STITCHES
THREAD IS TOUCHING ANOTHER PART OF BOARD
STITCHING ACROSS A COMPONENT
ON
OFF


CHECK FOR LOOSE CONNECTIONS
LOOSE LOOPS
UNRAVELLED KNOTS


CHECK FOR REVERSED POLARITY
OFF
ON





Homework:

Start thinking about your beautiful circuit.
Find conductive materials and experiment.