HCIN720
Designing User Experiences for Internet-Connected Devices

Dr. Daniel Ashbrook

Today

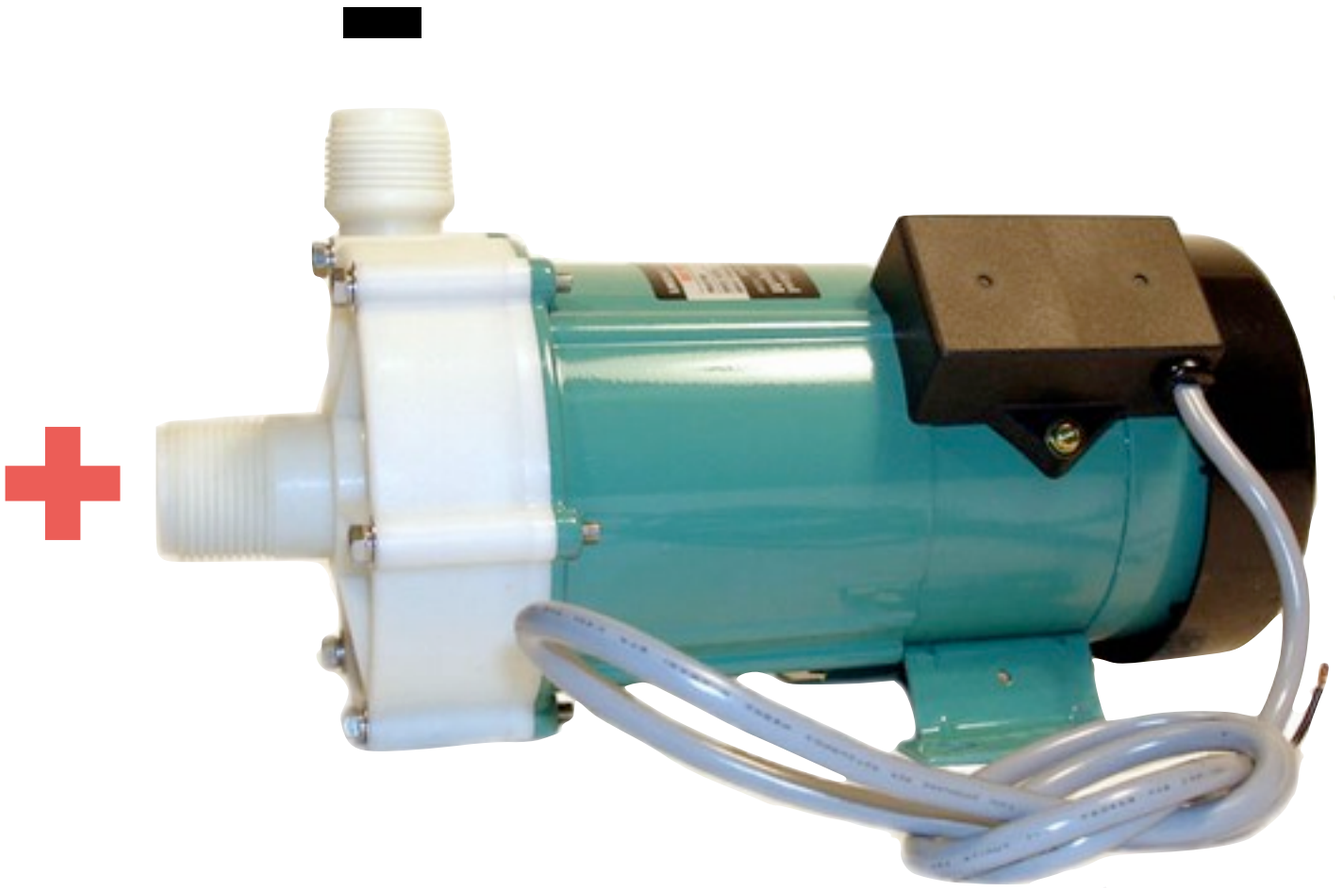
- Goal: hook some stuff up to our Photons
- Topics:
  - What is electricity & how to think about it?
  - How do breadboards work?
  - Light sensors: how do they work?
  - Attach a light sensor
  - Resistors, diodes, and capacitors
  - Reading a circuit diagram

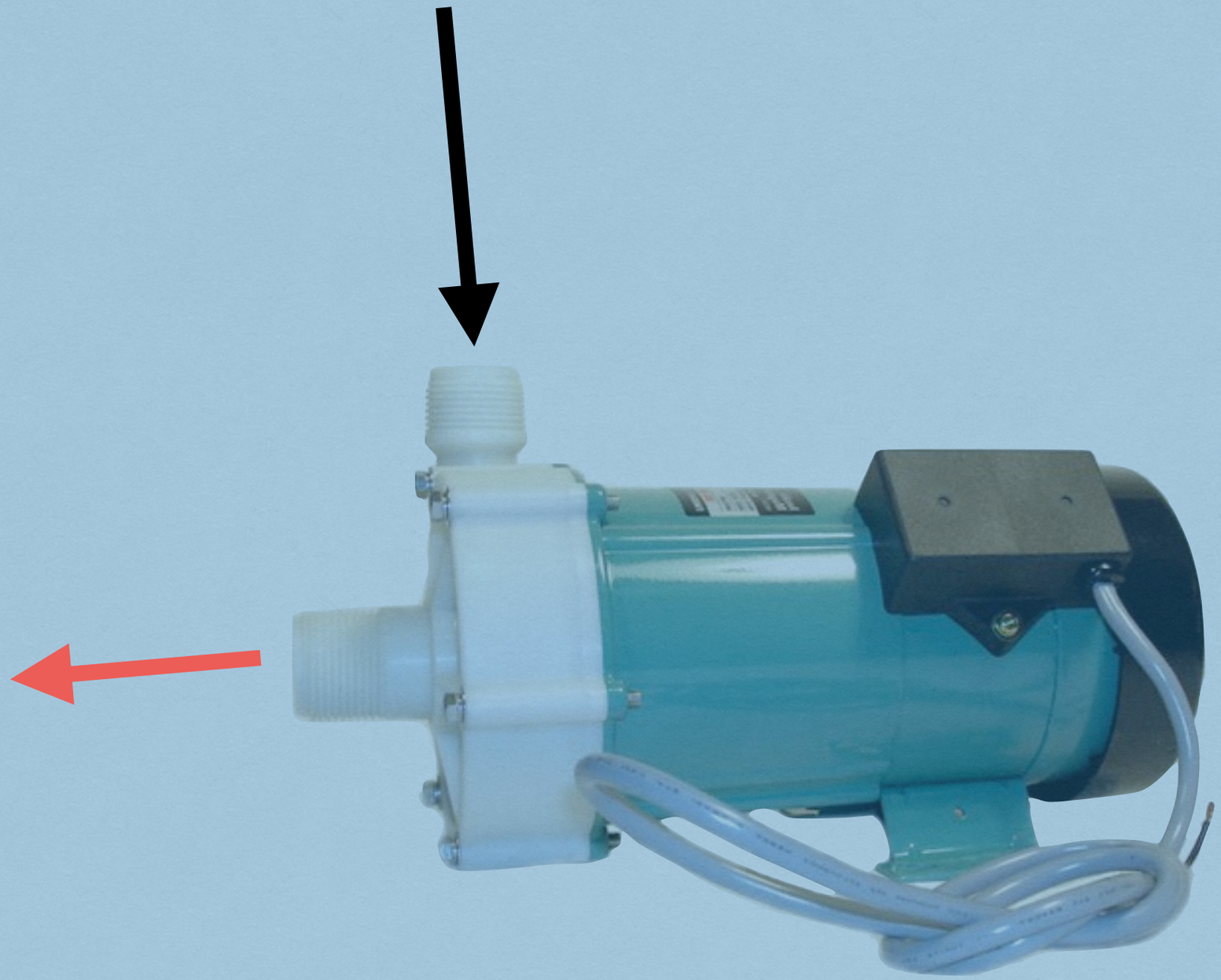
Attribution

Many of these slides borrowed from Jon Froehlich's class CMSC838, Tangible Interactive Computing, at the University of Maryland

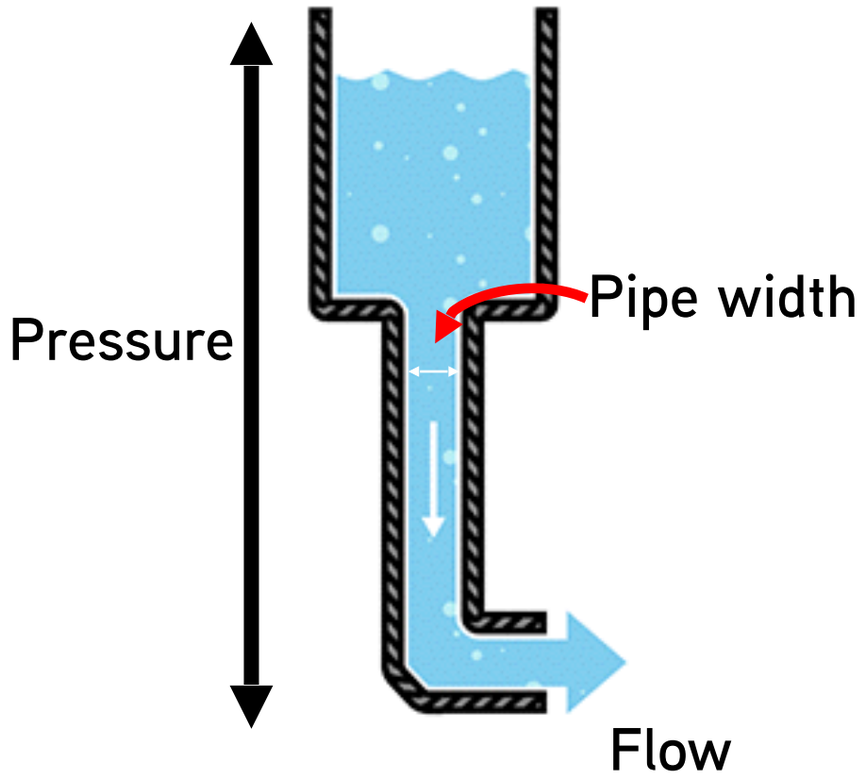
Electricity


AA
MN1500
LR6
1.5 VOLTS
DURACELL®
ALKALINE BATTERY
CAUTION: DO NOT CONNECT IMPROPERLY



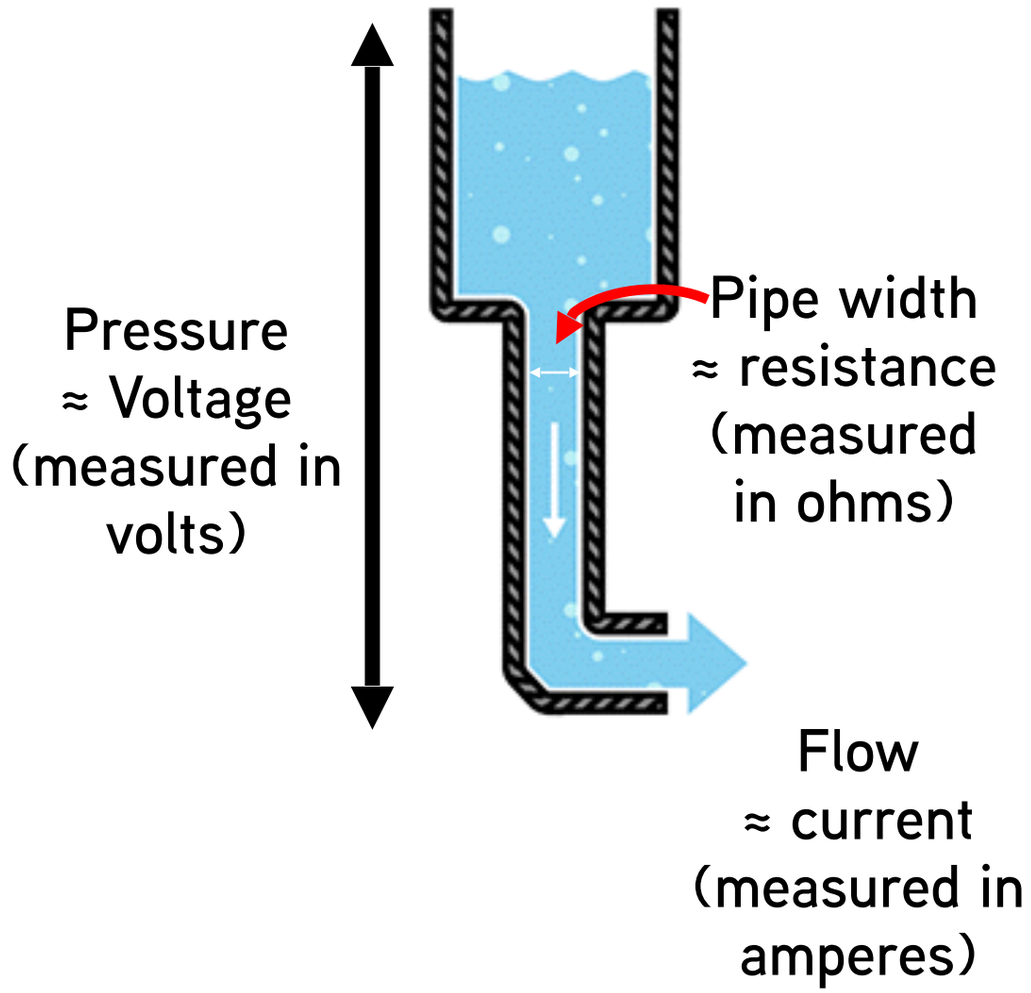


Water Analogy for DC Circuits



[based on: https://learn.sparkfun.com/tutorials/voltage-current-resistance-and-ohms-law/all]

Water Analogy for DC Circuits



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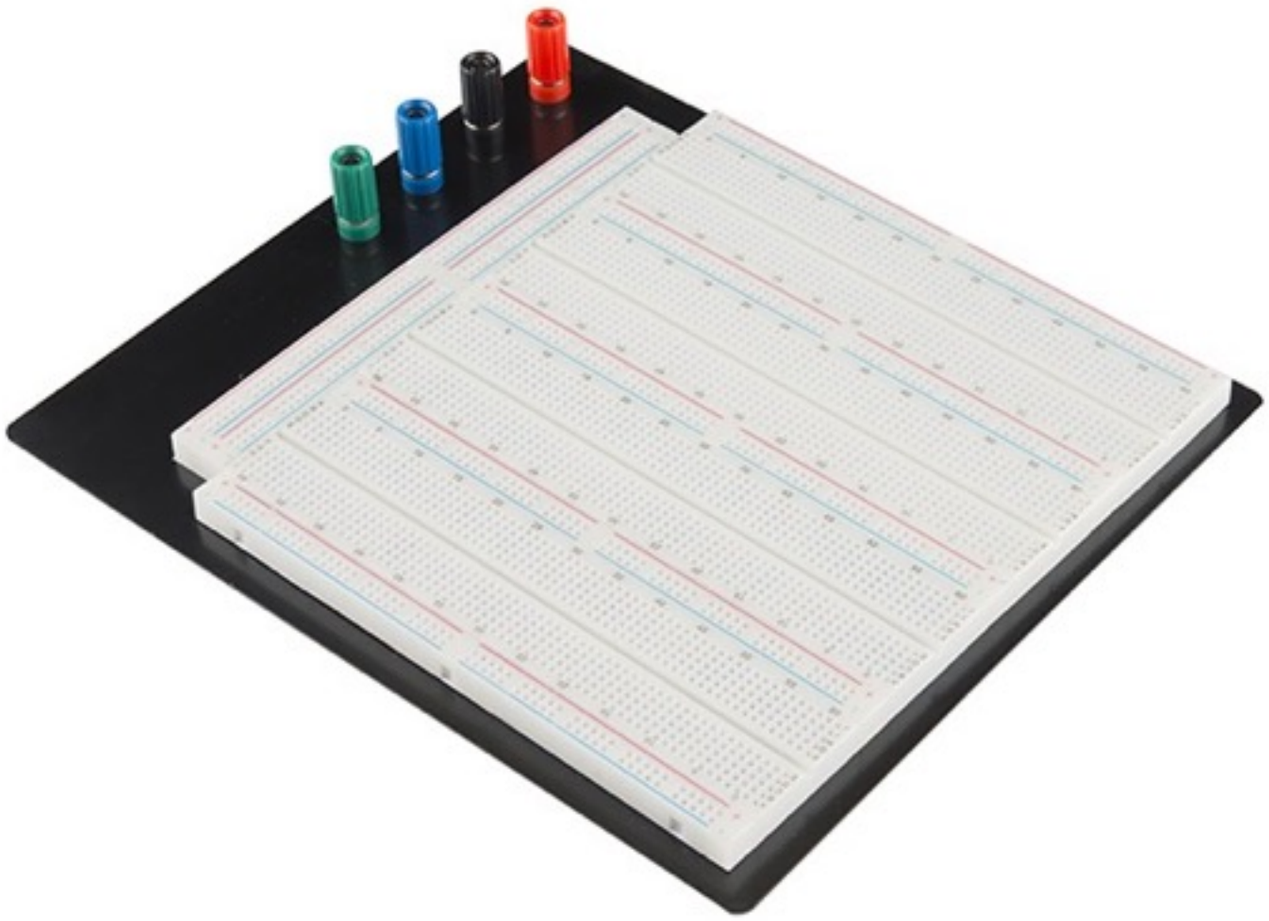
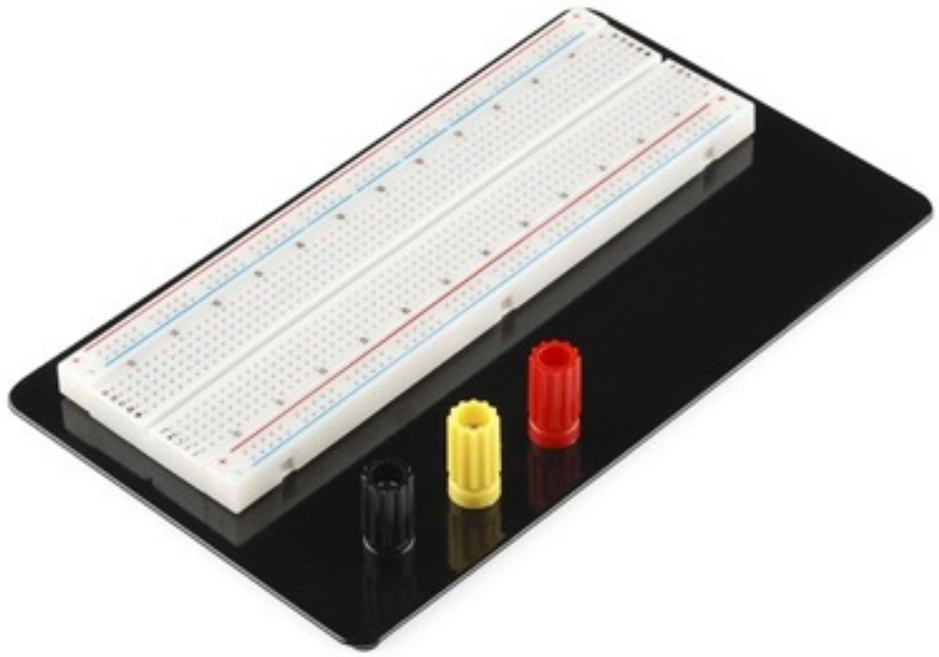
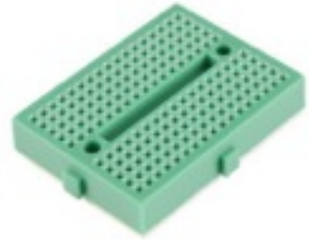
Breadboards

Breadboards: Lots of Variety

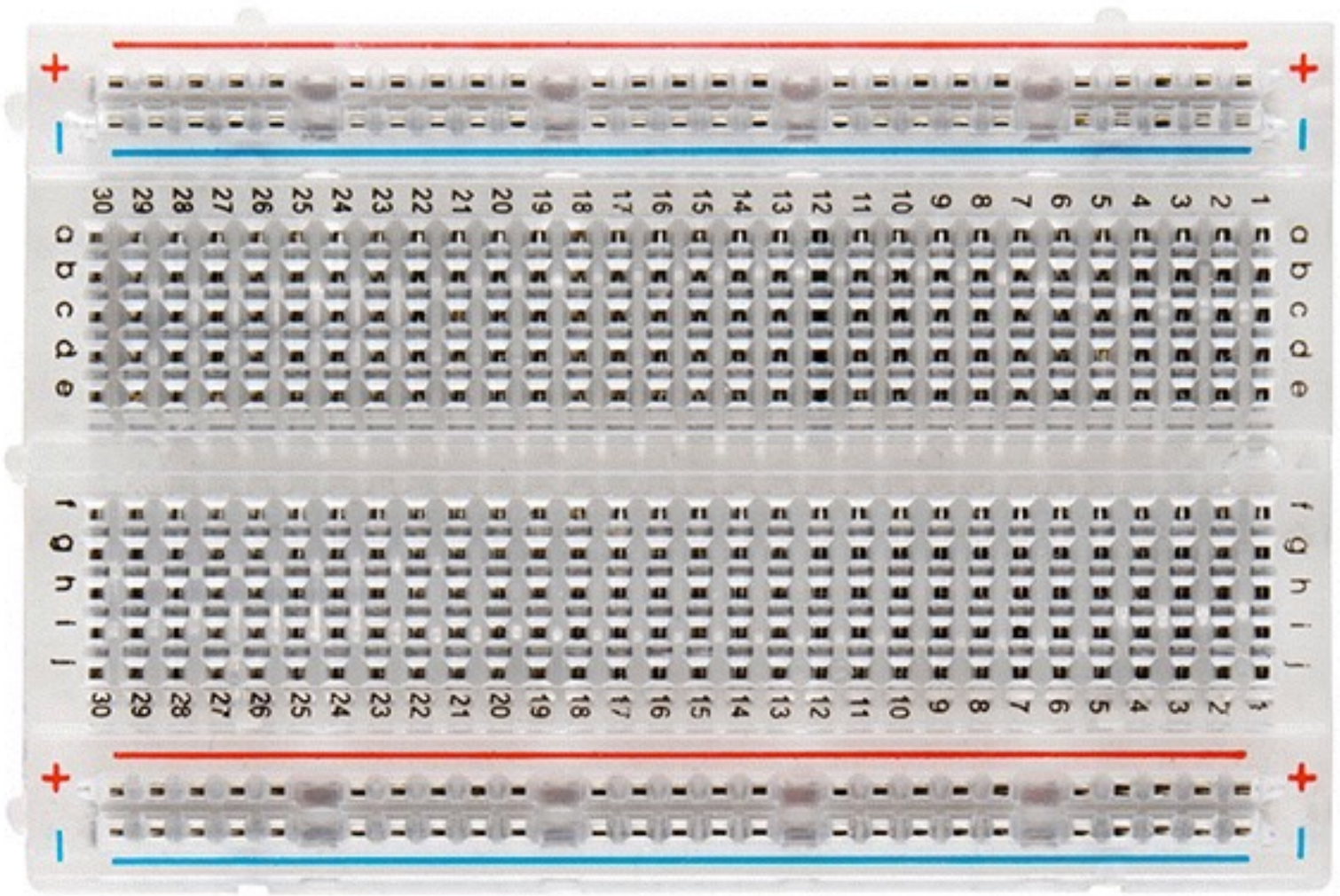






[source: sparkfun.com]

Breadboards: How They Work



[source: https://learn.sparkfun.com/tutorials/how-to-use-a-breadboard,]

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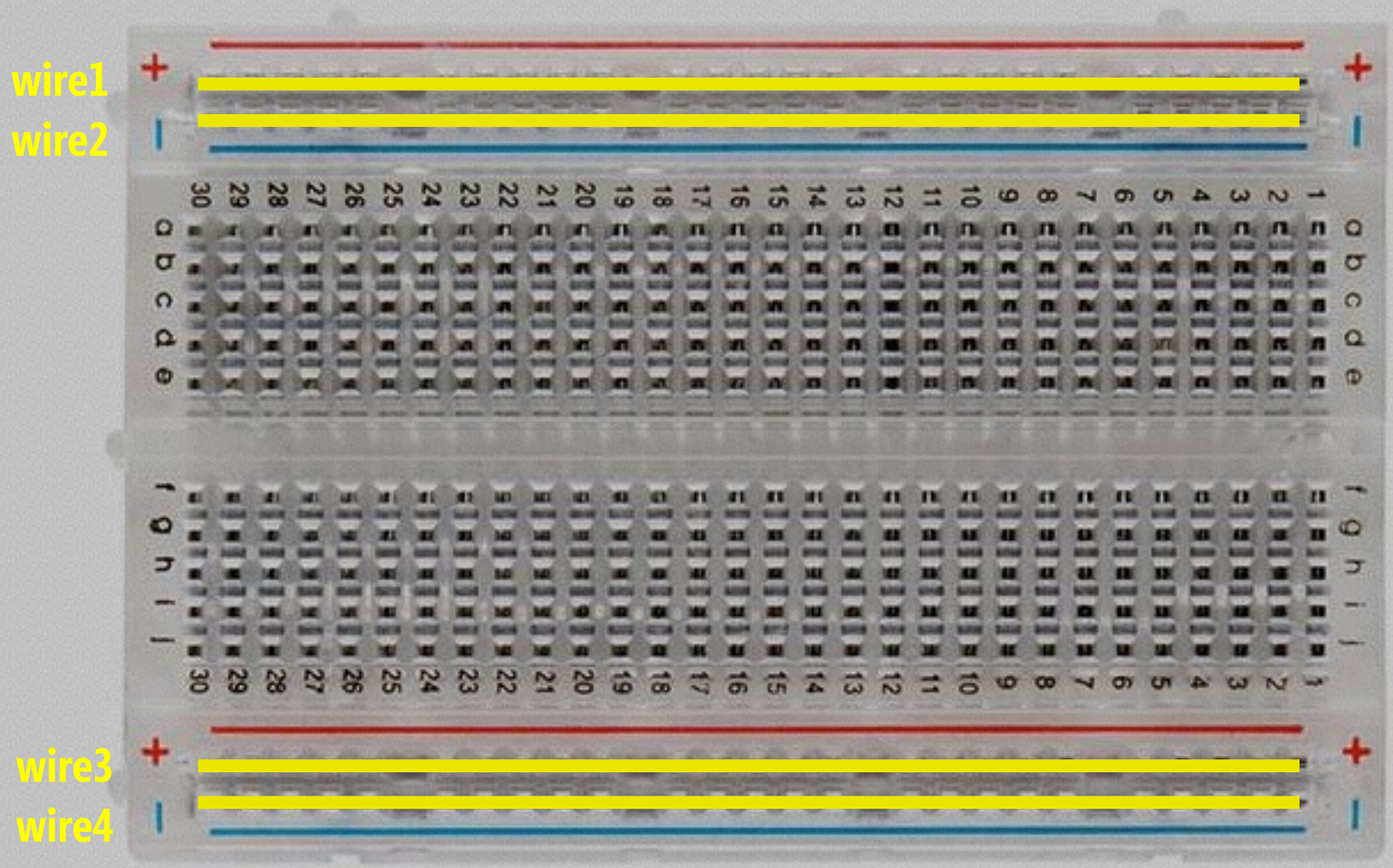

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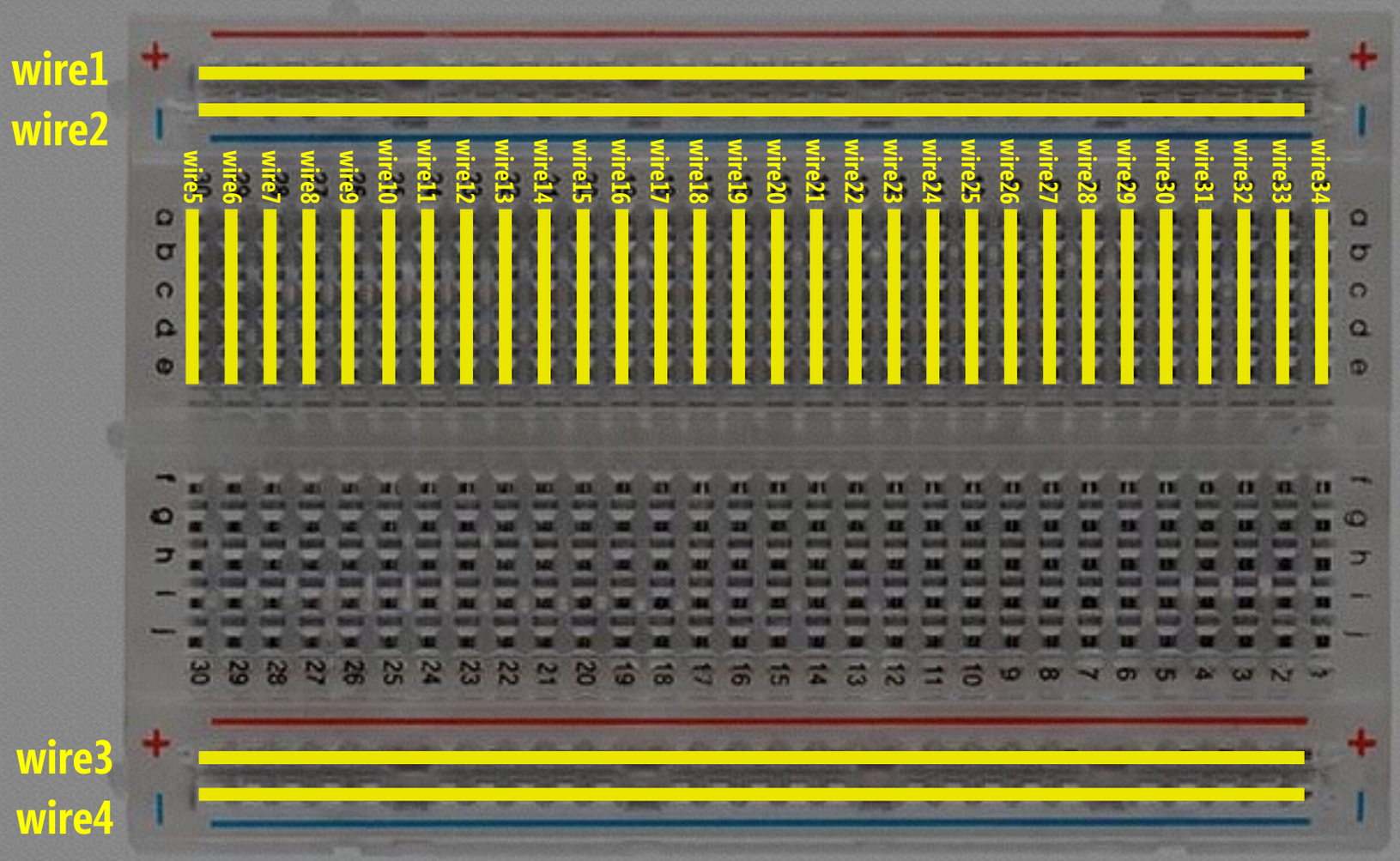
Breadboards: How They Work



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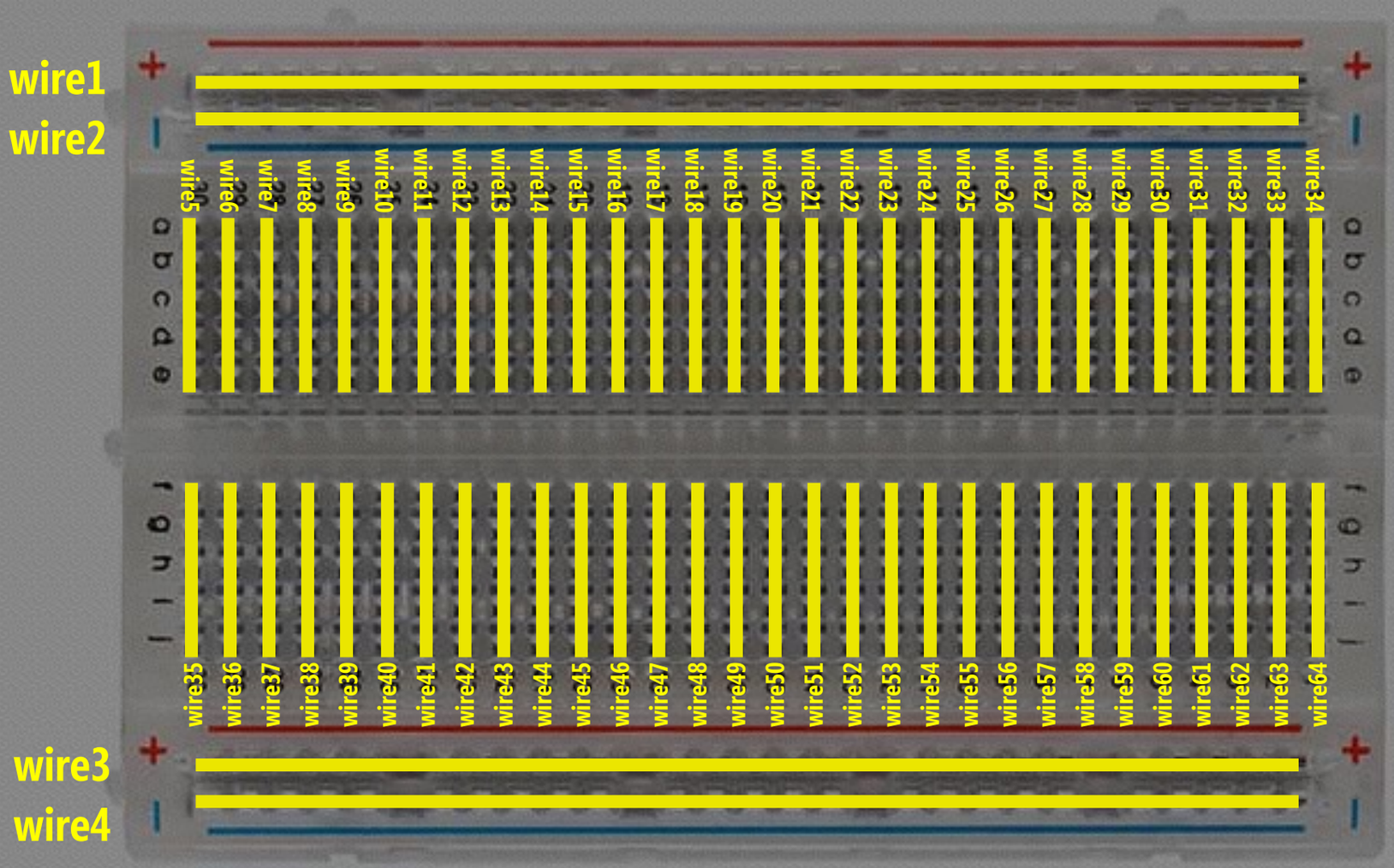
Breadboards: How They Work



[source: https://learn.sparkfun.com/tutorials/how-to-use-a-breadboard,]

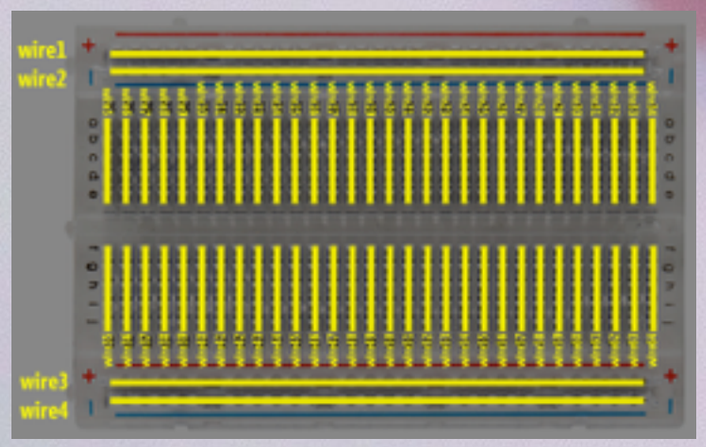
Breadboards: A Look Inside

Breadboard now flipped over (you're looking at the back with the insulated backing peeled away)

[source: https://learn.adafruit.com/assets/17394, https://learn.sparkfun.com/tutorials/how-to-use-a-breadboard,]

Breadboards: A Look Inside

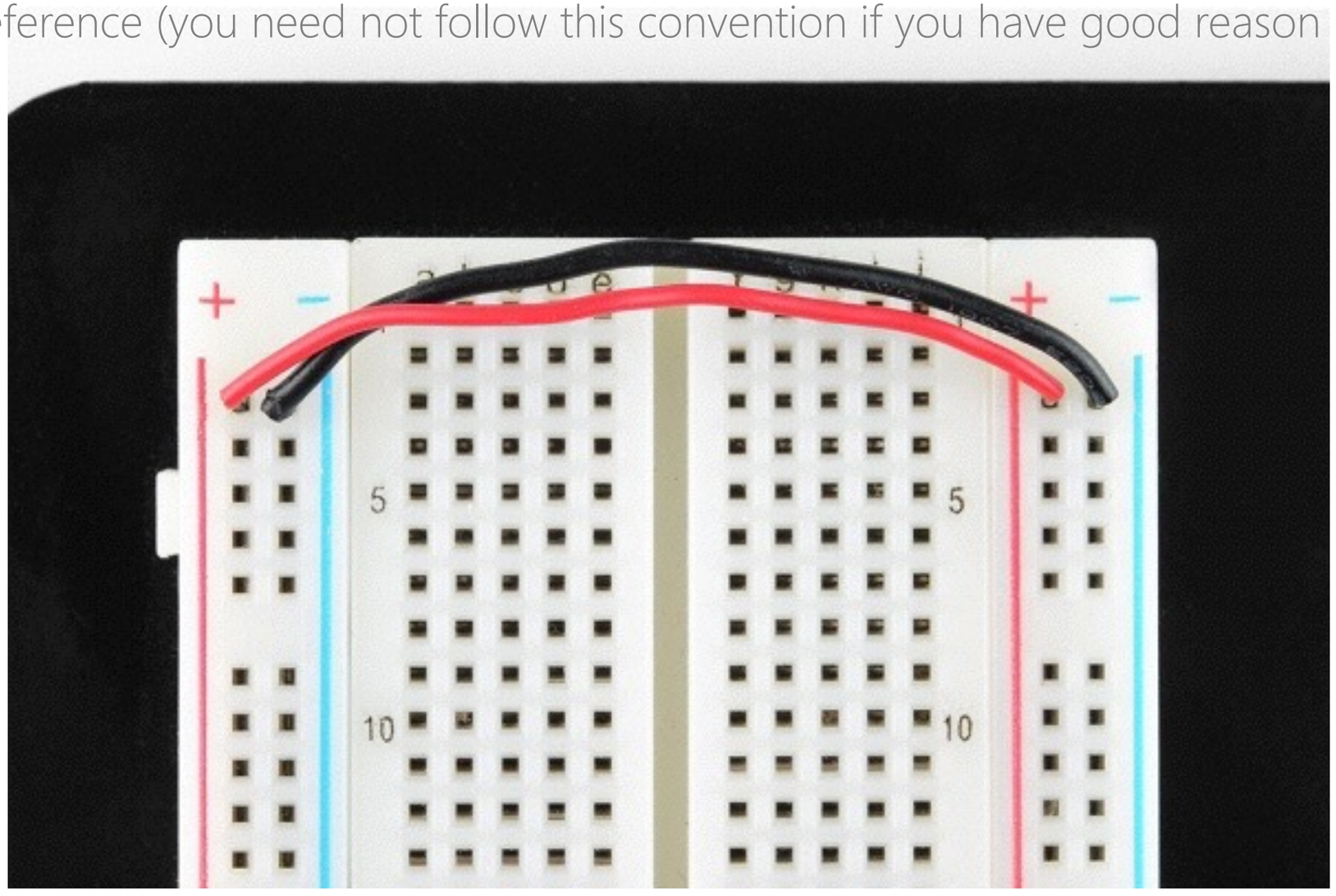
A single strip of conductive metal from breadboard column



[source: https://learn.adafruit.com/assets/17394, https://learn.sparkfun.com/tutorials/how-to-use-a-breadboard,]

Breadboards: A Quick Tip

The power rails on either side are not connected, so if you want the same power source on both sides, you will need to connect the two sides with some jumper wires. Keep in mind that the markings are there just as a reference (you need not follow this convention if you have good reason not to).



Two jumper wires used to connect the power rails on both sides. Always attach the '+' to '+' and the '-' to '-'. I also like to use 'black' wire for '-' and 'red' wire for '+'.

[source: https://learn.adafruit.com/assets/17394, https://learn.sparkfun.com/tutorials/how-to-use-a-breadboard,]

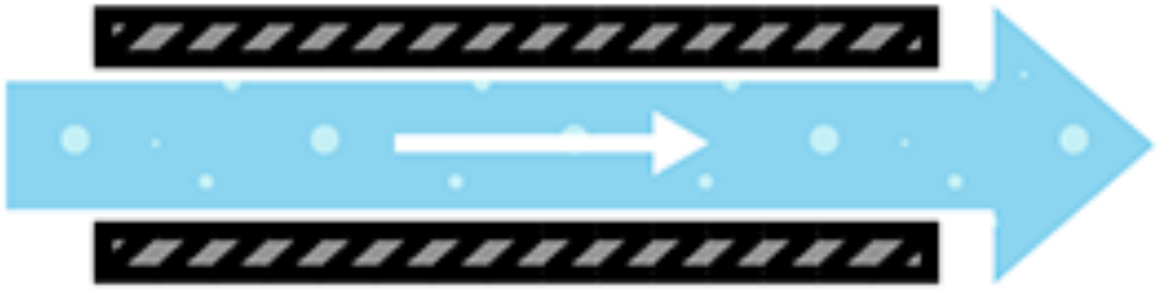
Breadboards: Like Legos!

Many breadboards have little nubbins and slots on the sides, and some even have them on the tops and bottoms. These allow you to connect multiple breadboards together to form the ultimate prototyping surface.

[source: sparkfun.com]

Photoresistors

Resistance



less resistance

more flow
(current)
more pressure
(voltage)

more resistance

less flow
(current)
more pressure
(voltage)

Ω
ohm

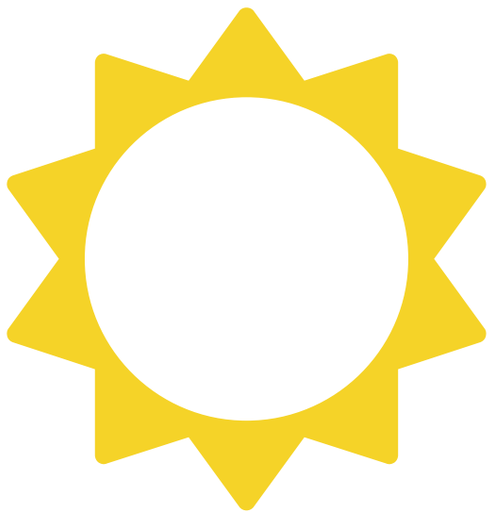
symbol

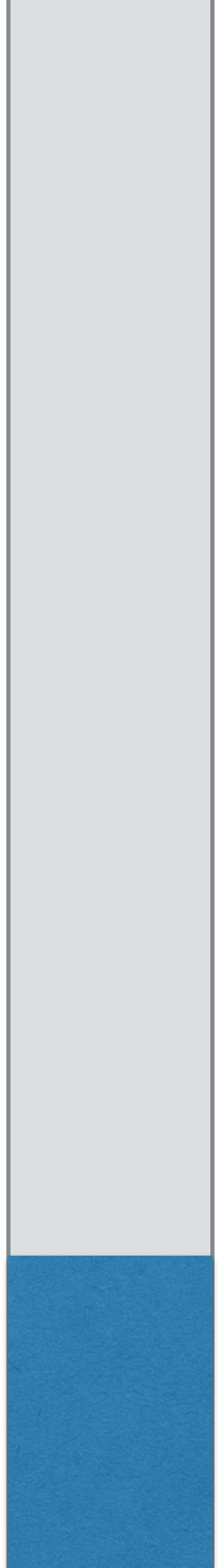
https://learn.sparkfun.com/tutorials/voltage-current-resistance-and-ohms-law/all

resistance
(Ω)

lots

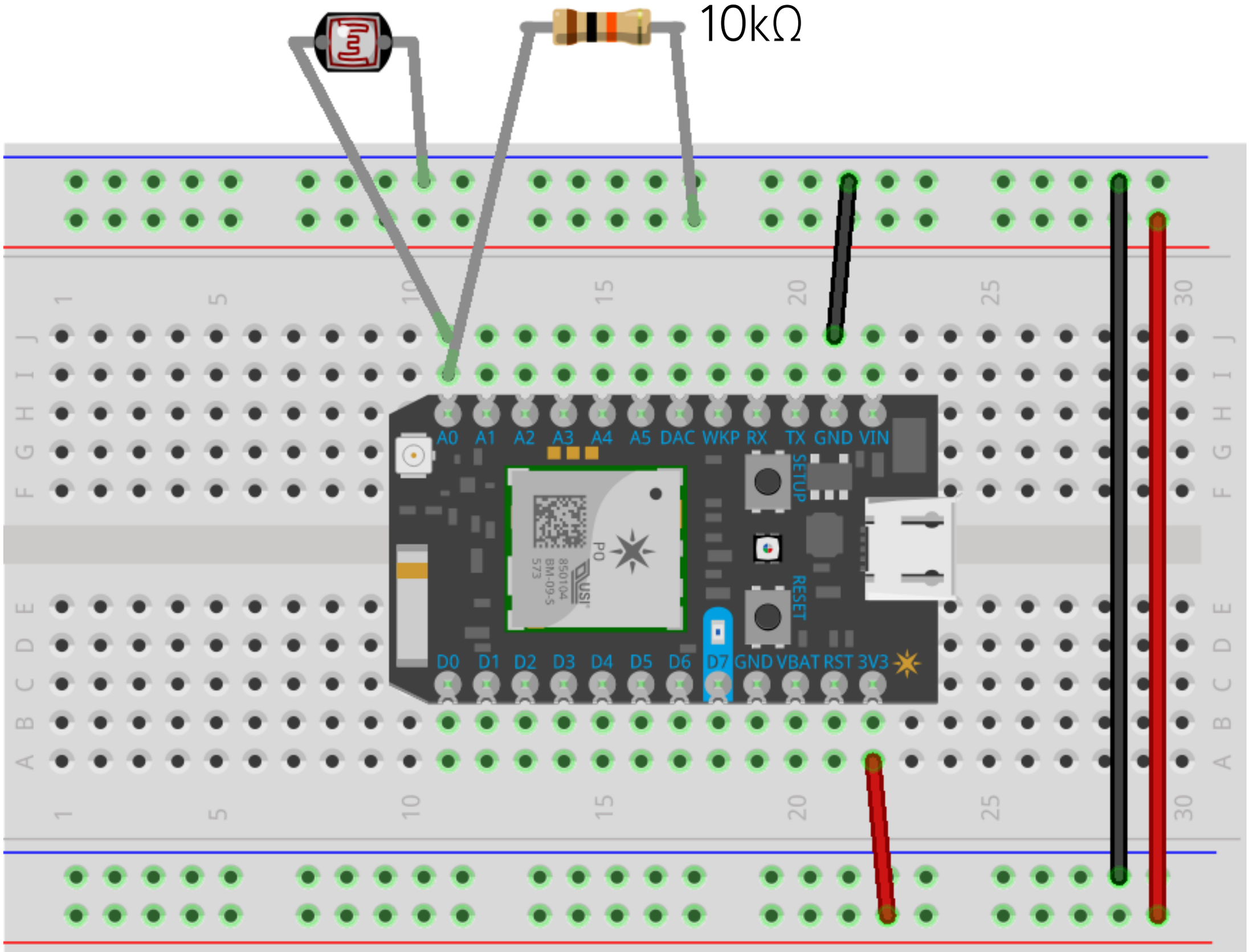
resistance
(Ω)





less

resistance
(Ω)


10kΩ
A0 A1 A2 A3 A4 A5 DAC WKP RX TX GND VIN
SETUP
RESET
D0 D1 D2 D3 D4 D5 D6 D7 GND VBAT RST 3V3
P0
1 5 10 15 20 25 30
A B C D E F G H I J

analogread.ino

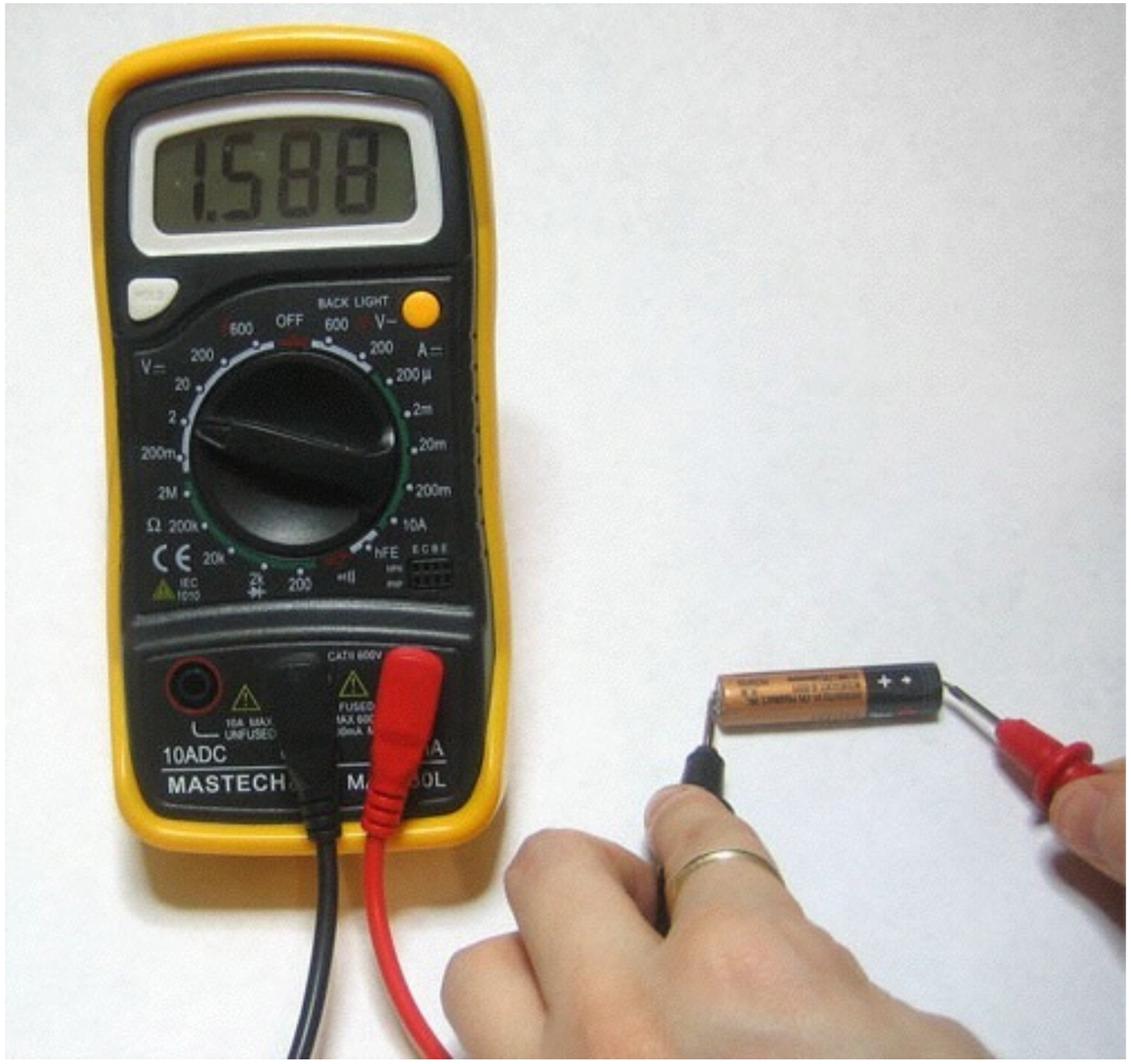
```
SYSTEM_MODE(SEMI_AUTOMATIC);    //Disable WiFi

void setup()
{
  Serial.begin(9600);
}

void loop()
{
  Serial.println(analogRead(A0));
  delay(250);  //So we can read the output
}
```

```
particle compile photon analogread.ino --saveTo analogread.bin

particle flash --usb analogread.bin

particle serial monitor
```

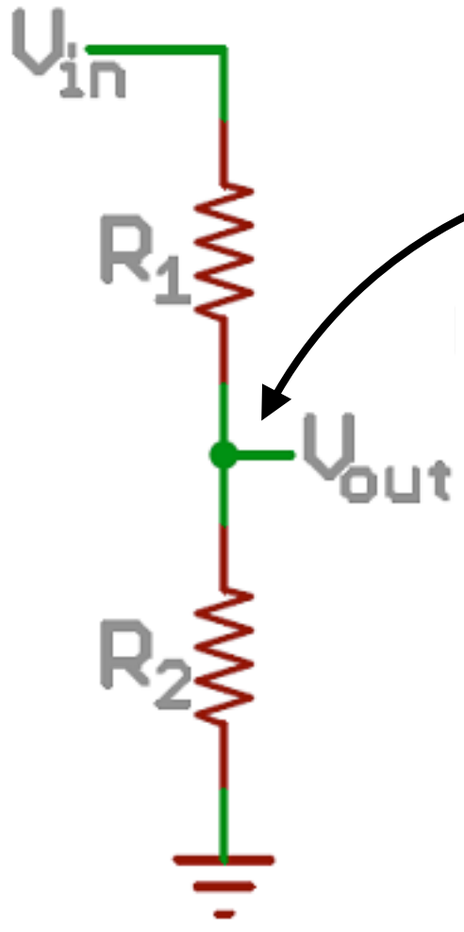
What's happening?

Measuring voltage

Multimeter

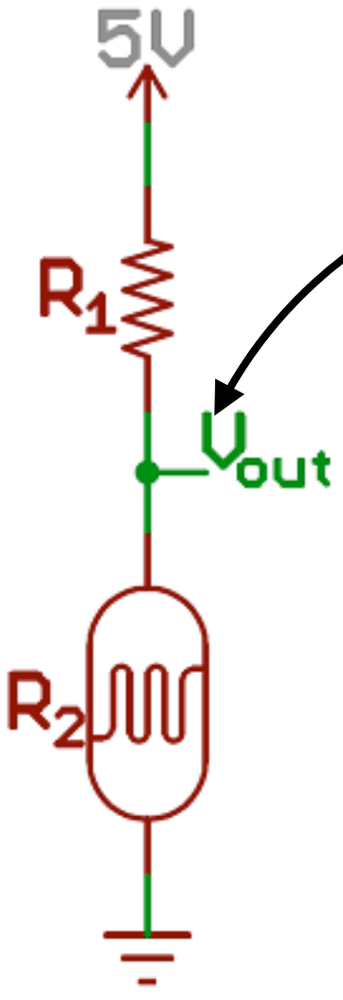


Voltage divider circuit



$$V_{out} = V_{in} \cdot \frac{R_2}{R_1 + R_2}$$

Voltage divider circuit



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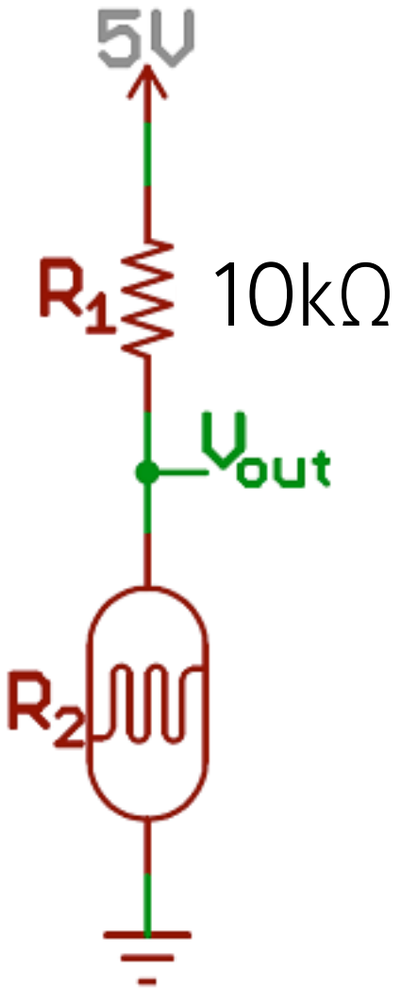
Voltage divider circuit



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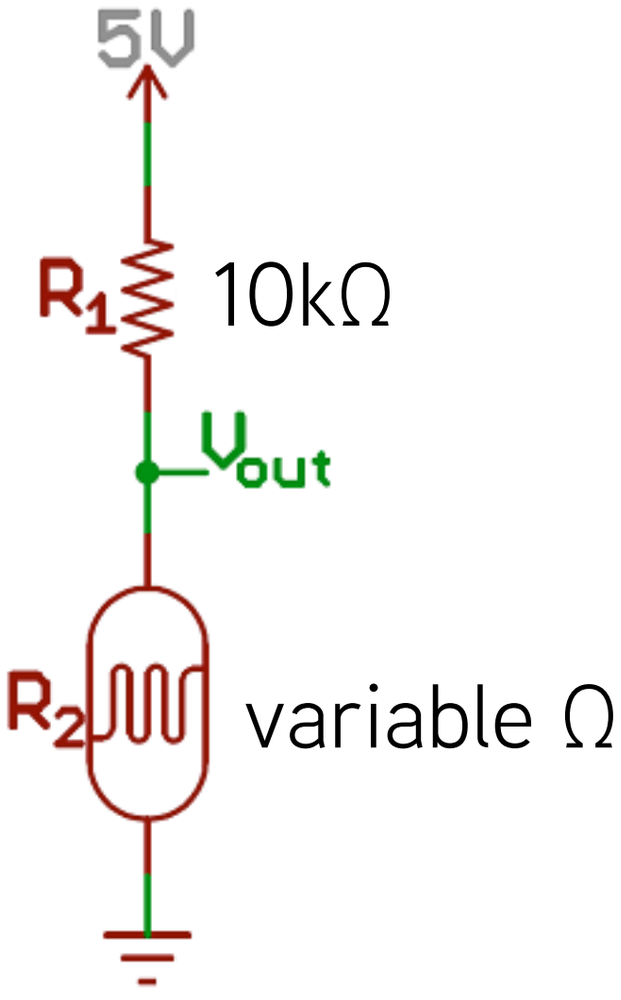
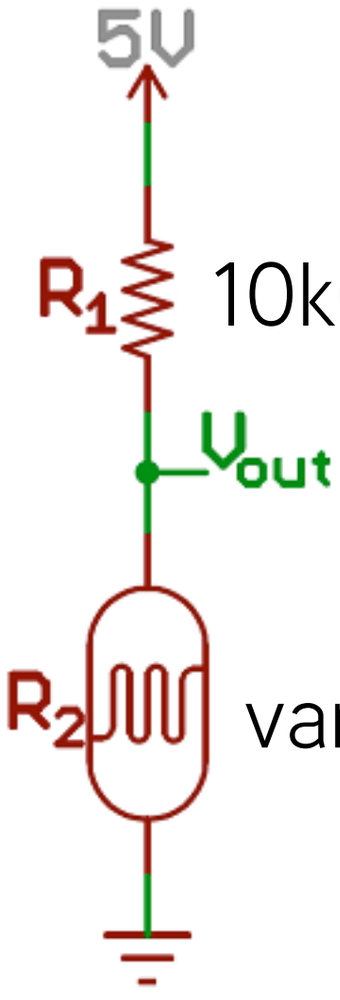


$$V_{out} = V_{in} \cdot \frac{R_2}{10\text{k}\Omega + R_2}$$

Voltage divider circuit



$$V_{out} = V_{in} \cdot \frac{R_2}{10\text{k}\Omega + R_2}$$

R2 low → Vout low

R2 high → Vout high