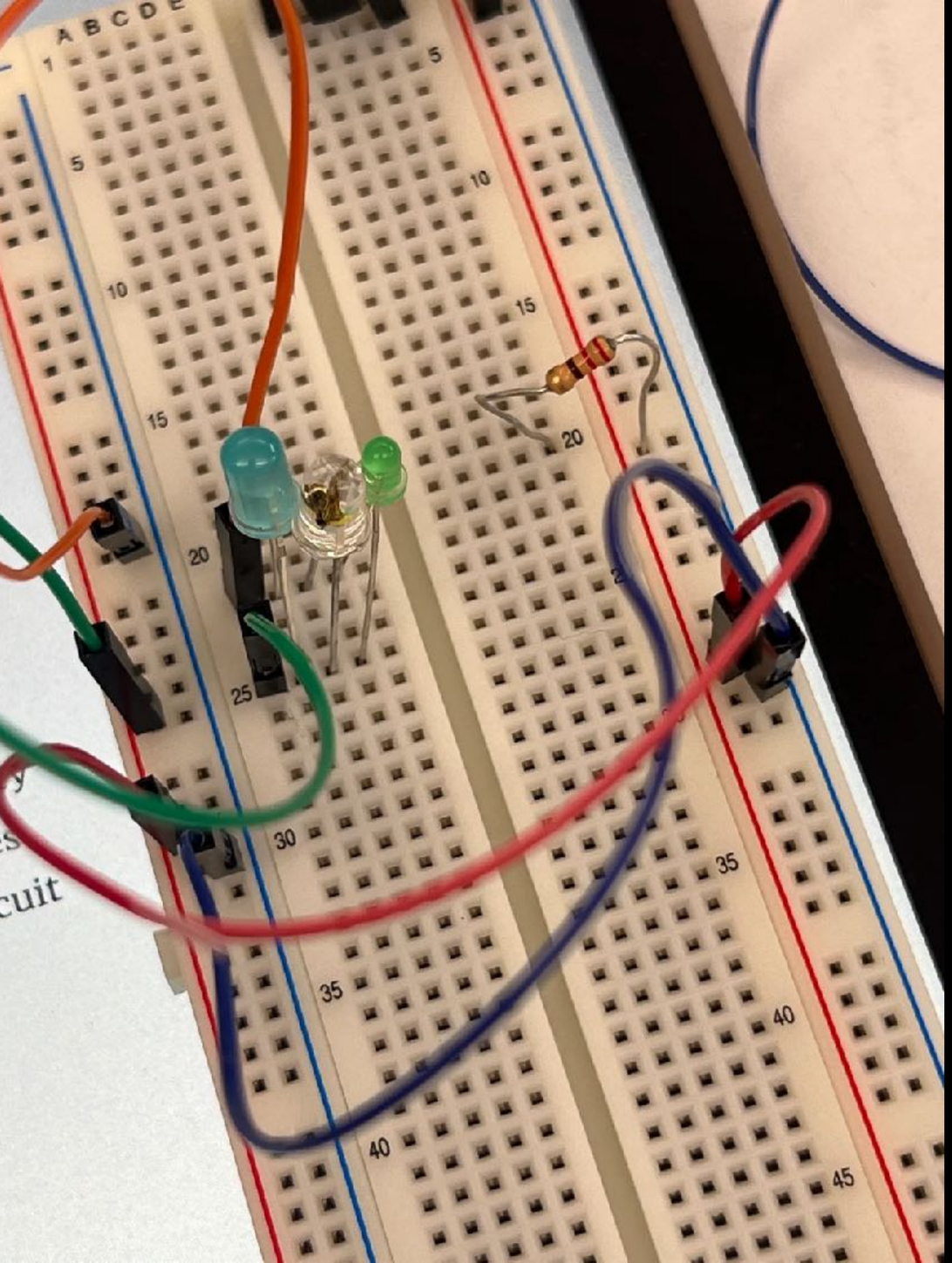
Class 2 Agenda

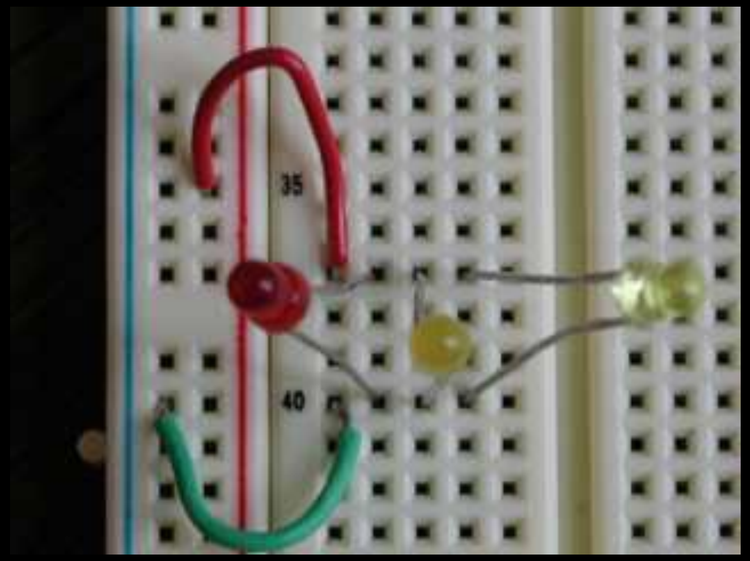
- Note: Upcoming class 4 reschedule to **MONDAY September 22**
- Open Q&A - how was Week 1?
- Fantasy Device round 2 - smell recording and playback
- Review/Workshop Week 1 Labs
  - Components, basic breadboard setup, multimeter
- Electricity Notes
- Preview Week 2 Labs
  - Install Arduino IDE, Upload first program
- Discuss reading (time allowing)

Fantasy Device

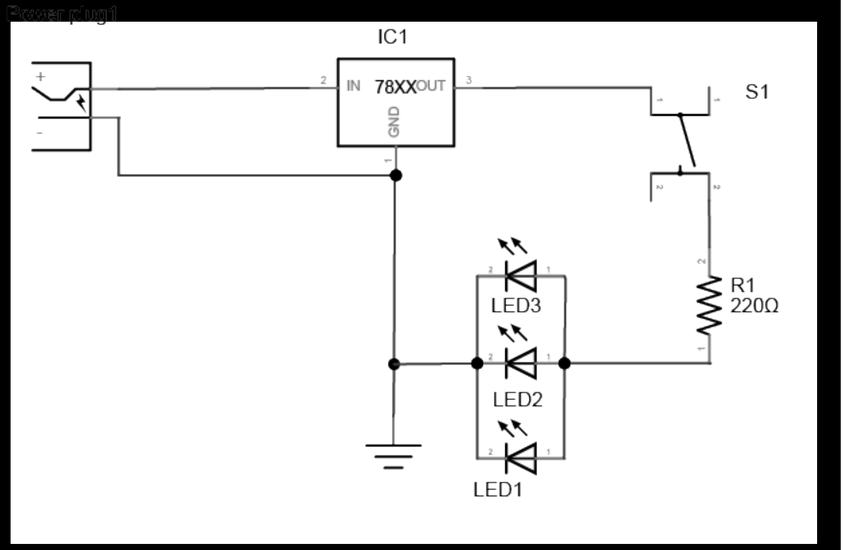
- Form **four groups**
- Two groups focus on smell **capture**; other two groups focus on smell **playback**
- In each case:
  - what is the physical form?
  - Where and how is it used?
  - What features of the form (affordances) promote the use?
  - Is it intended for professional or consumers?
  - Does it have consumables, and if so how are they managed?

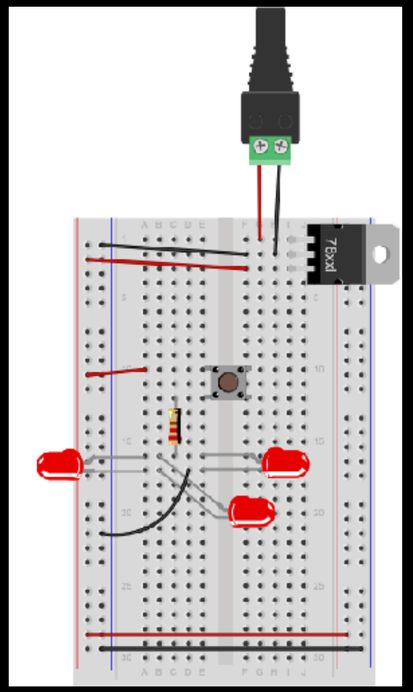
Some current existing chemical sensors



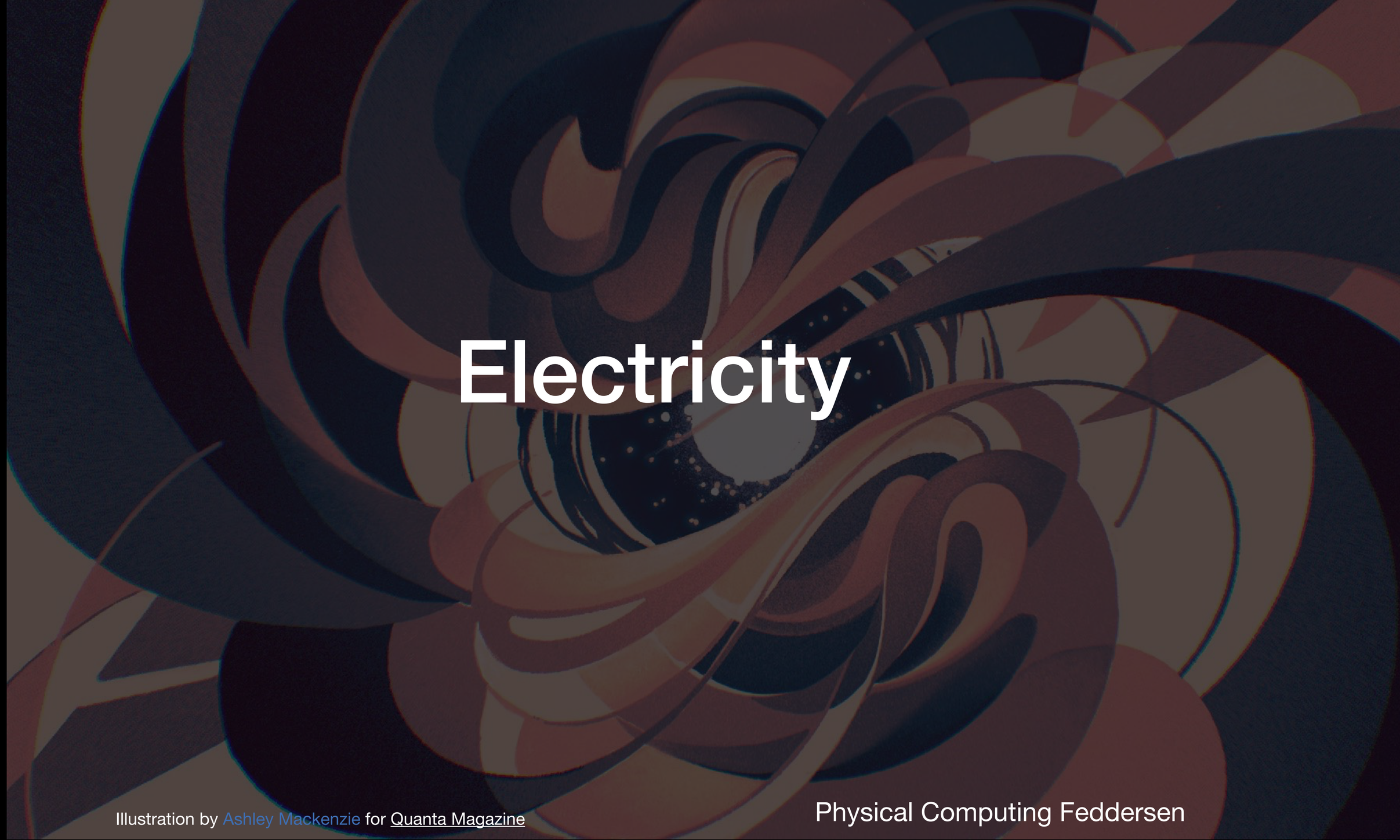


Components Lab





Electricity Lab



Electricity

Illustration by Ashley Mackenzie for Quanta Magazine

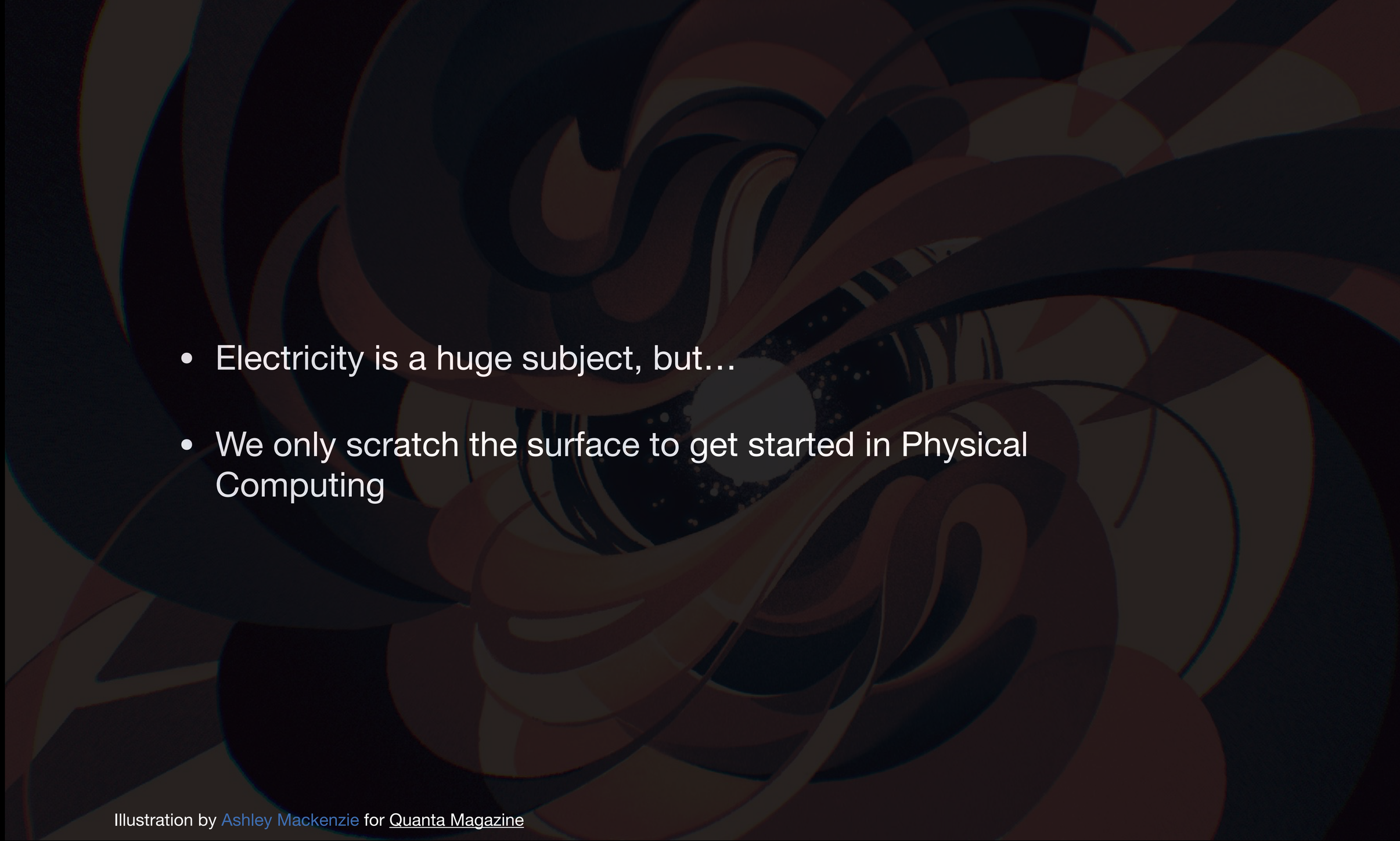
Physical Computing Feddersen

Everything is electricity!*

- Electromagnetism is a fundamental force in the universe, and the only one we experience directly.
- Electricity is powerful, subtle, strange, useful, but ultimately predictable.
- We've only had any idea about electrons for about 100 years! Our current understanding of them is really weird!

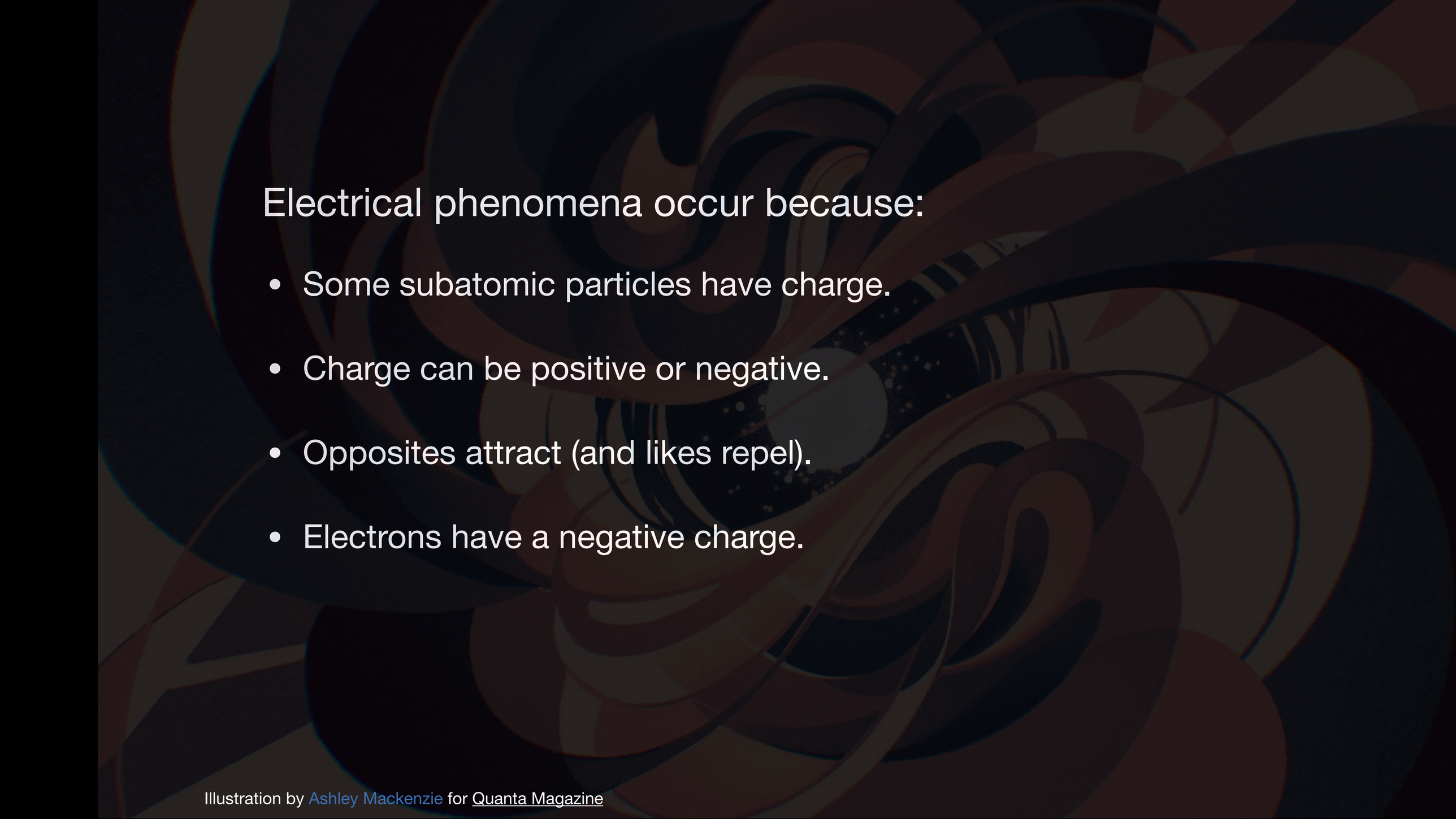
Illustration by Ashley Mackenzie for Quanta Magazine

* and magnetism



- Electricity is a huge subject, but…
- We only scratch the surface to get started in Physical Computing

Illustration by Ashley Mackenzie for Quanta Magazine



Electrical phenomena occur because:

- Some subatomic particles have charge.
- Charge can be positive or negative.
- Opposites attract (and likes repel).
- Electrons have a negative charge.

Illustration by Ashley Mackenzie for Quanta Magazine

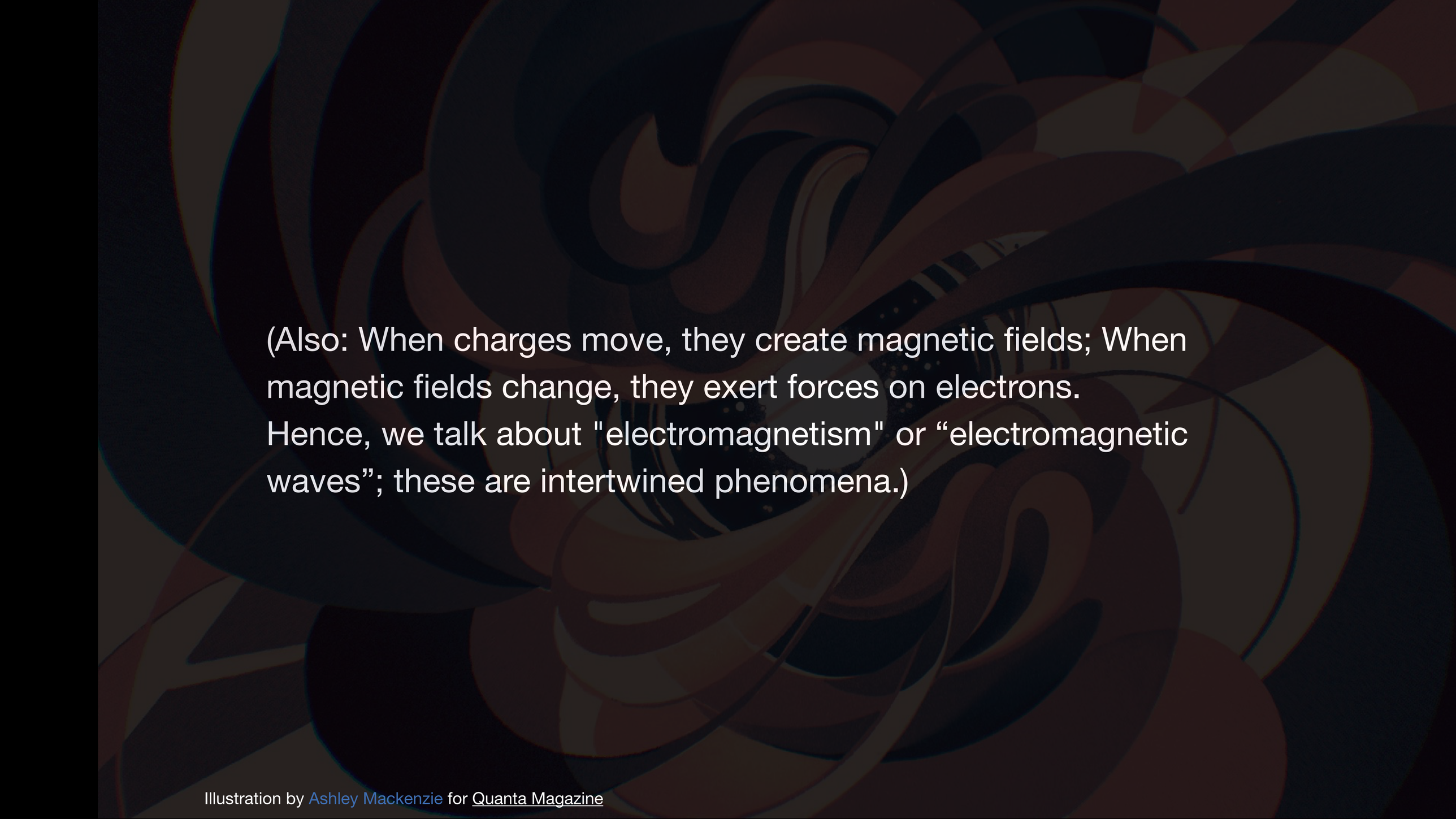
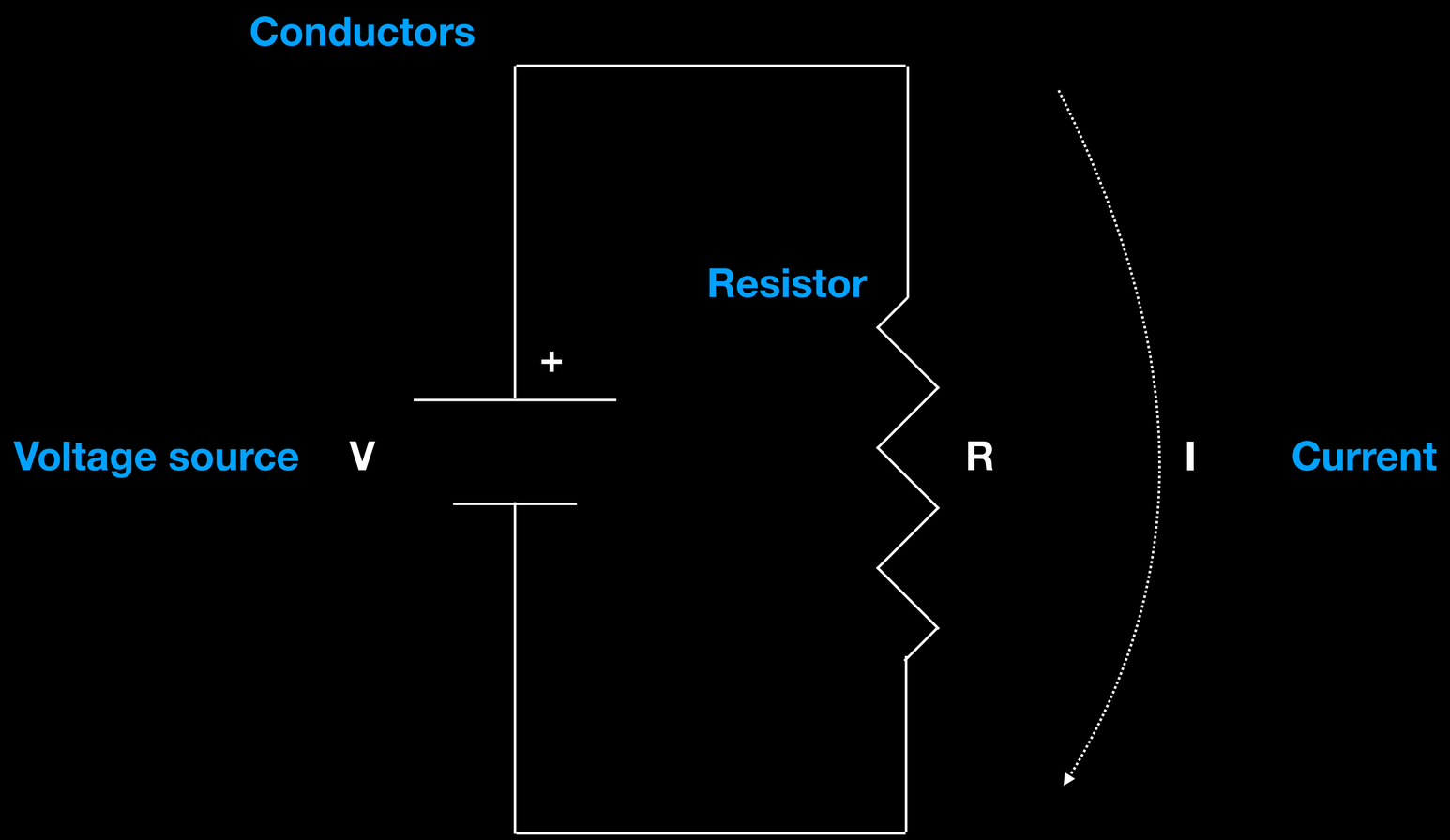


Illustration by Ashley Mackenzie for Quanta Magazine

We’re going to figure this out:

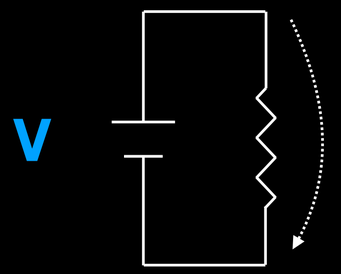


- We can consider any two points in regards to how charges would flow between them if they could.

image: https://www.javelin-tech.com/

- We measure that potential for charge to flow as a "VOLTAGE" with the unit Volts, V.

- Voltage is always a measurement between two points.



- In this class, we don't care (much) about shocks, we care about situations where **charge flows for a long time**.
- This is the job of batteries and power supplies.
- The first characteristic of any power supply is its Voltage.
- Consider a battery - 1.5V, 9V, 12V, etc.
- Or a “wall wart”: 12V, 16V. Or AC (what that means comes later) 120V, 220V

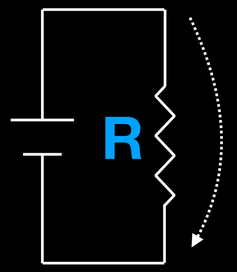
image: duracell

- Every material has an ability to allow electrons to flow through it.

- Some things are good at it, like most metals. These are called “conductors.”

- Some things are bad, like wood, plastic, or air. These are “insulators.” They have a low conductivity, or conversely, a HIGH RESISTANCE.

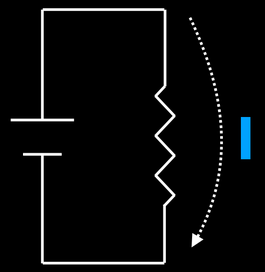
- RESISTANCE is the second property we care about. It's unit is Ohms, Ω.



- Voltage is measured between two points, and every (DC) power supply has a positive and negative (or positive and “GROUND”) side.

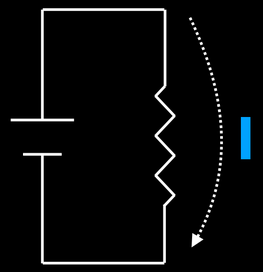
- The path from positive to negative, through some stuff, is called a CIRCUIT.

- Flowing charge is called CURRENT, measured in Amps (A) and noted in circuits as “I”



- If a Voltage source is connected in a circuit by a HIGH RESISTANCE path, virtually no charge will flow (LOW CURRENT).

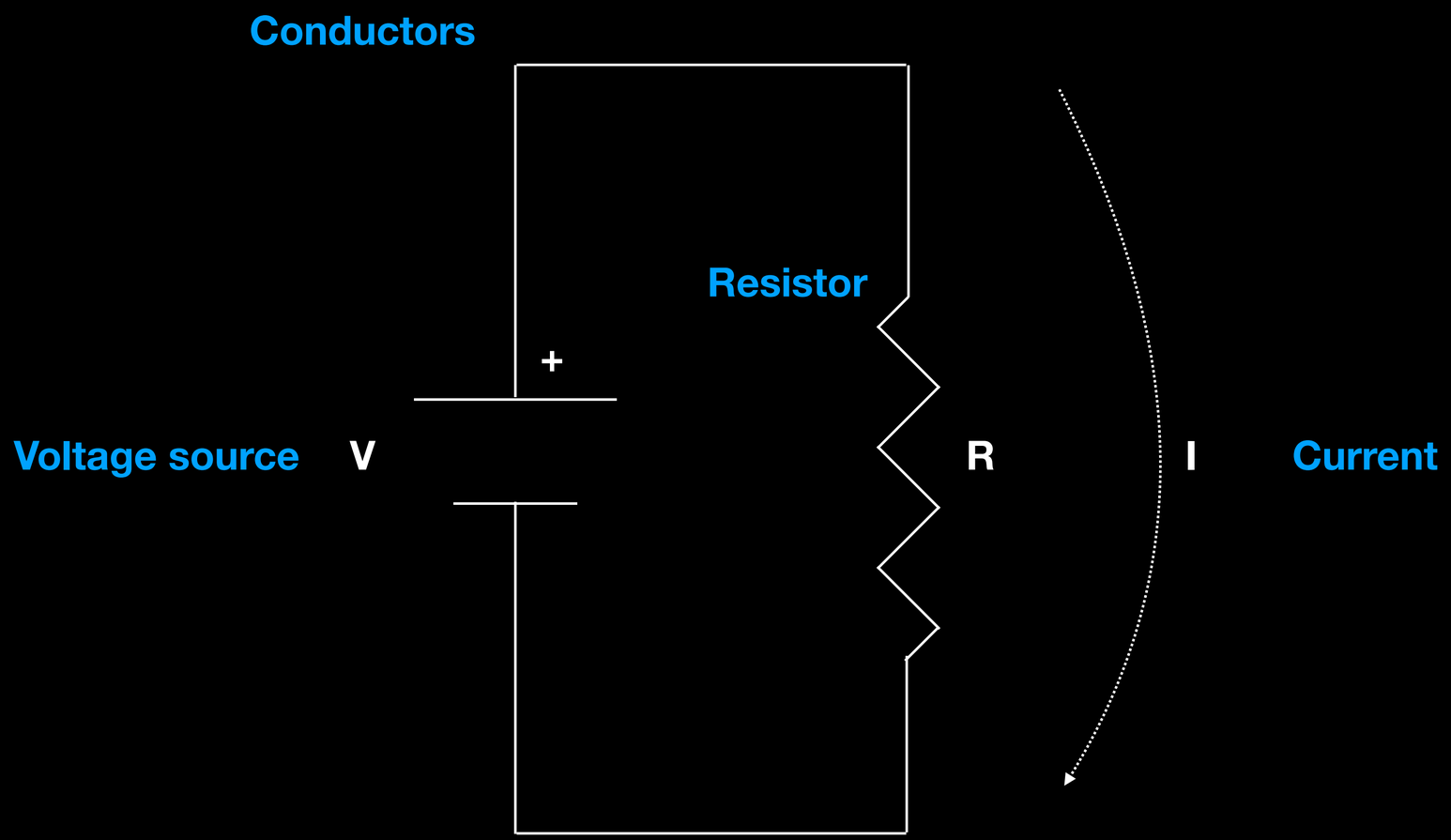
- If a Voltage source is connected in a circuit by a LOW RESISTANCE path, a lot of charge will flow (HIGH CURRENT).



We can say this with math:

$$I = V/R$$

Here’s our schematic again:



Our goal this week was to build the foundation for the Labs you will do in the coming weeks.

- Use a power supply or the Nano to get 3.3V for prototyping circuits
- Set up a breadboard
- Use a multimeter to make measurements of Voltage and Resistance (bonus points for Current!)
- See some basic components and their schematic symbols

For any electrical power supply ask:

- What voltage is it?
- How much current *could* it source?

image: https://www.circuitspecialists.com/

DC Volts

Resistance

DC Current

Continuity

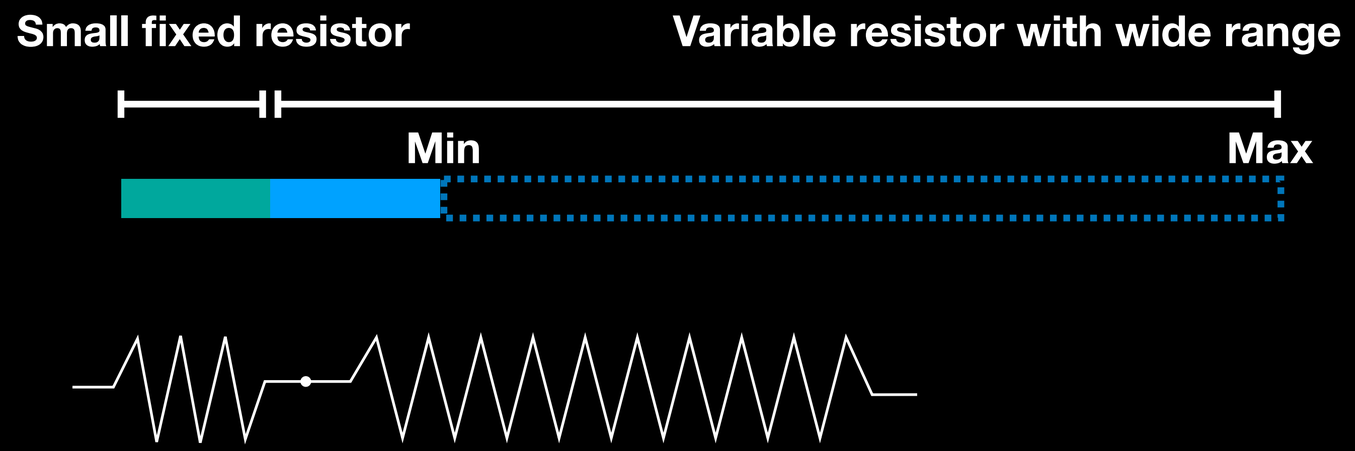
Steve found a Chinese version

Everything important about electricity*

- Volts, Resistance, Current, **related** as I=V/R
- **Circuits are circles** made up of components.
- Components include power supplies, wires, resistors, diodes (& LEDs)
- Switches and buttons and breadboards are just **fancy wire** (conductors and insulators in useful configurations)
- Potentiometers are **fancy resistors**
- **Variable resistors** - resistance changes because of something else (light, force)
- Diodes let electricity flow one way, we especially care about the ones that light (LEDs)
- Some components are **polarized**, some aren't
- Memorize the schematic symbols for each components (they generally look like what they are)
- Get used to translating from schematic layout to breadboard layout (just takes practice). Look for things in series or in parallel
- Memorize the voltage divider circuit

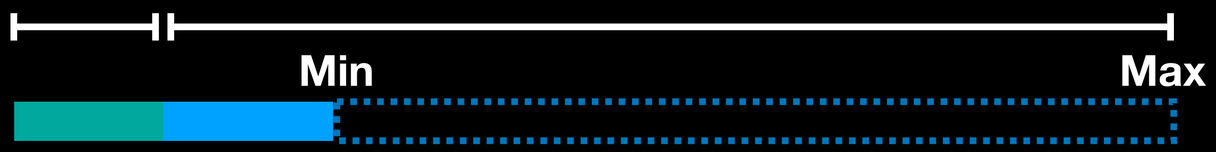
*as far as intro pcomp is concerned

Small fixed resistor


Small fixed resistor
Variable resistor with wide range
Min
Max

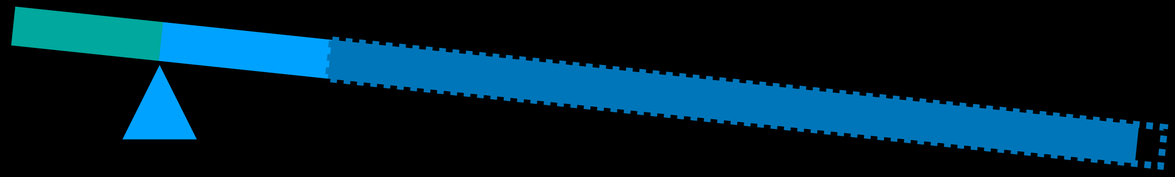
Small fixed resistor

Variable resistor with wide range



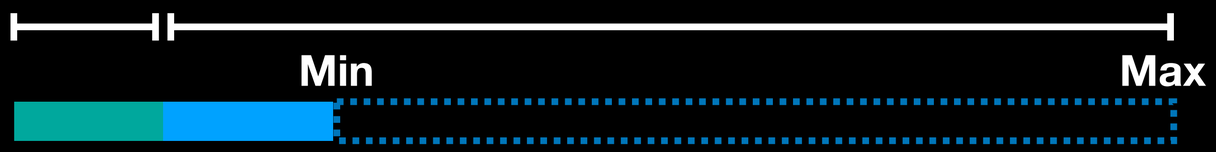
Example:

FSR, not pressed, high resistance



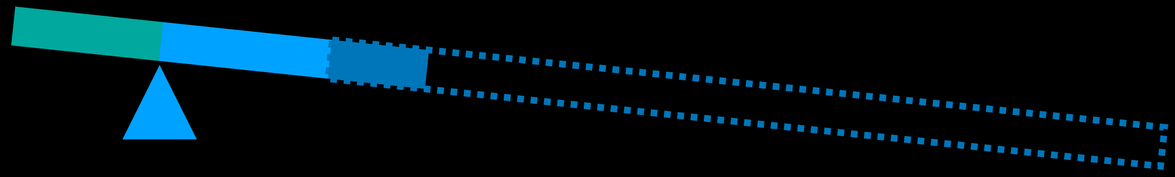
Small fixed resistor

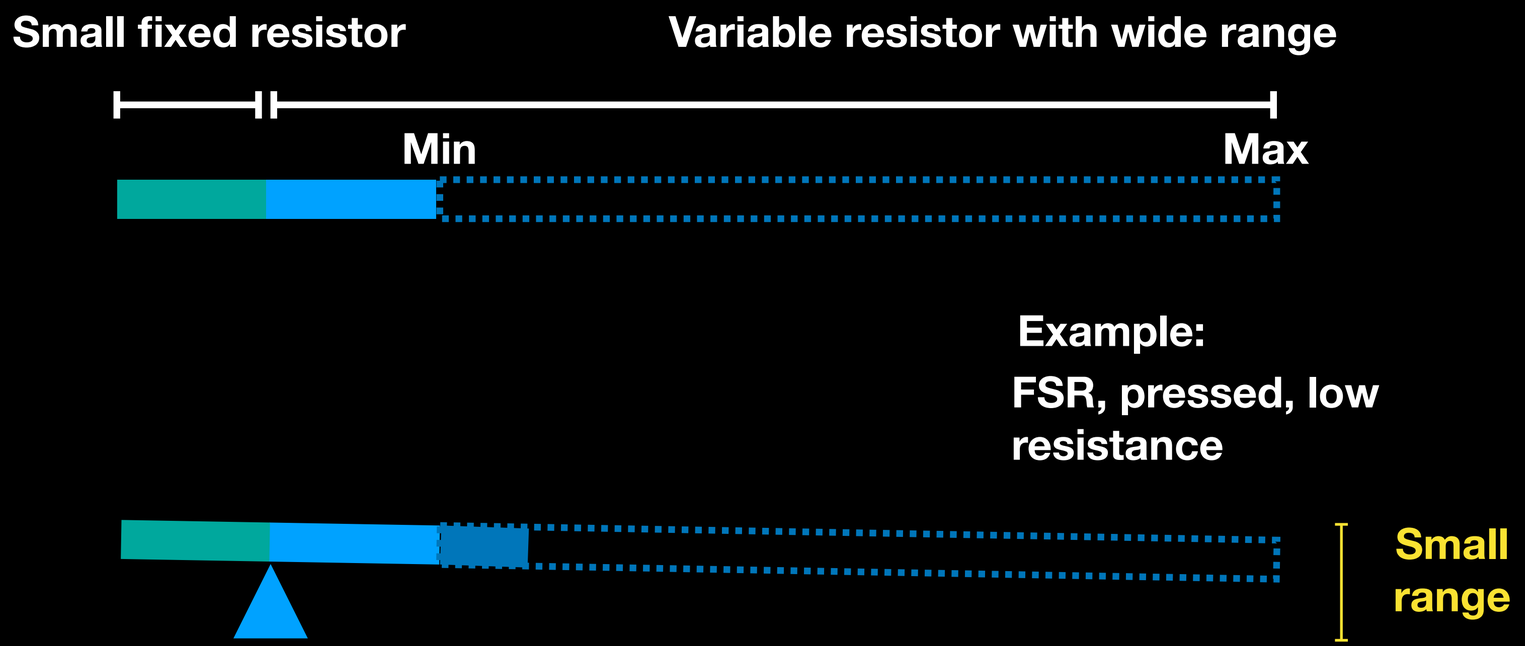
Variable resistor with wide range

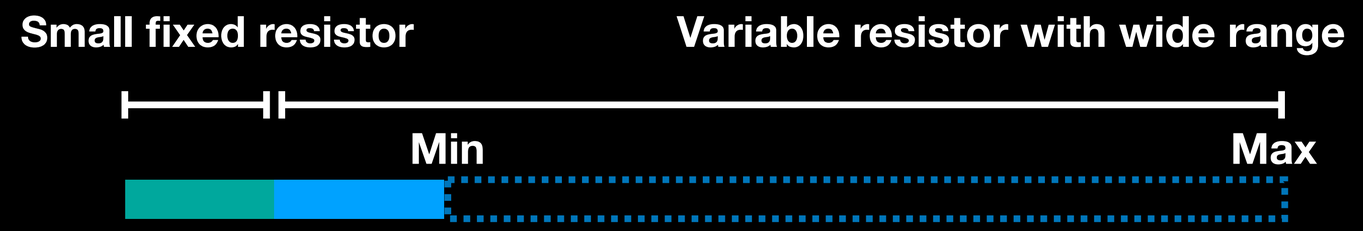


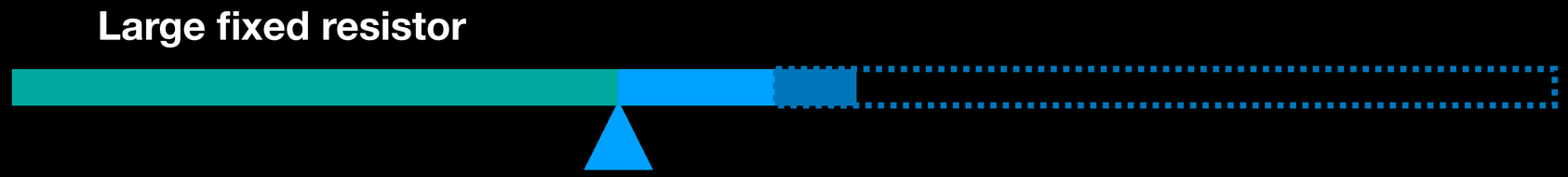
Example:

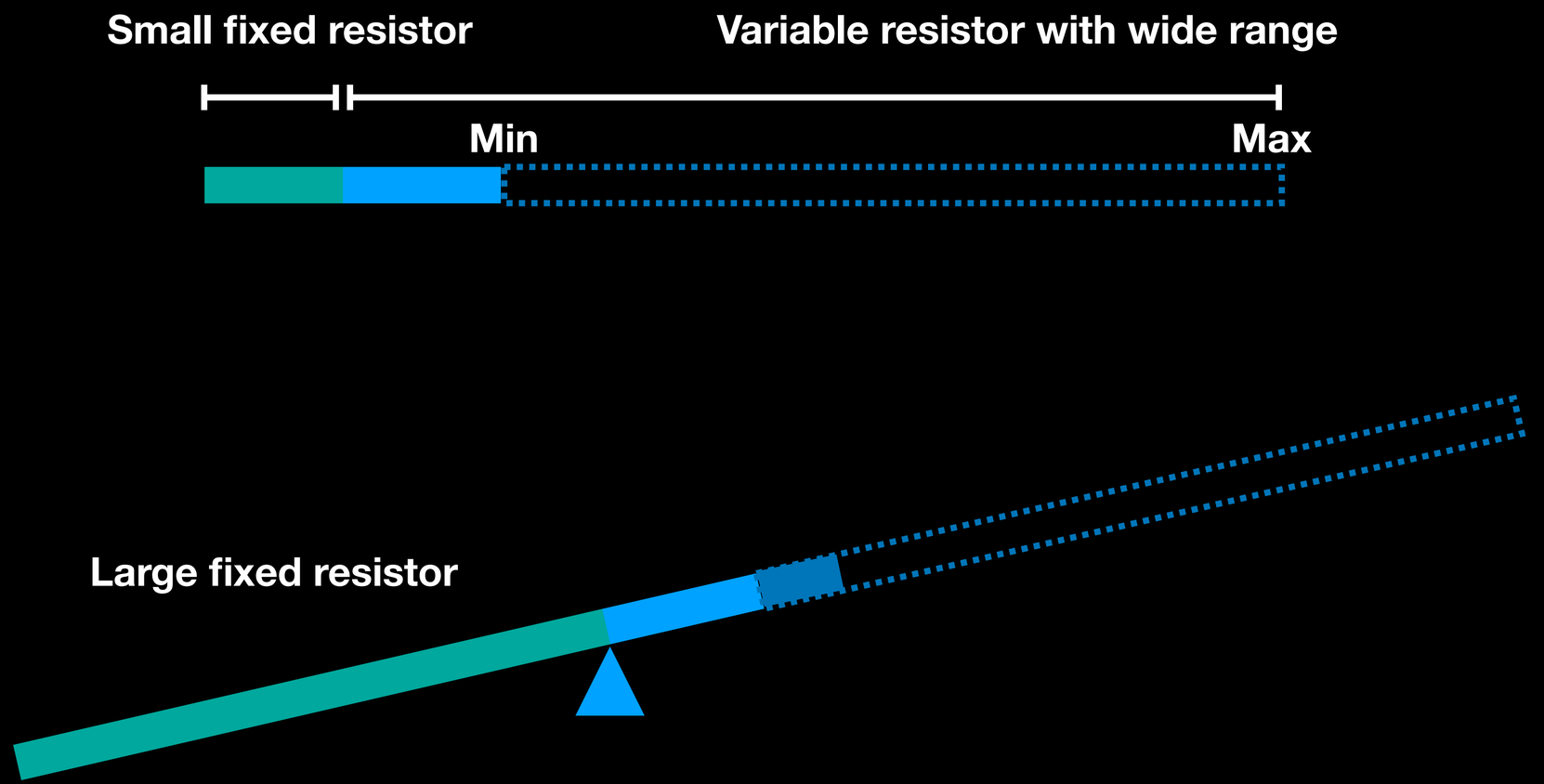
FSR, being pressed, resistance dropping

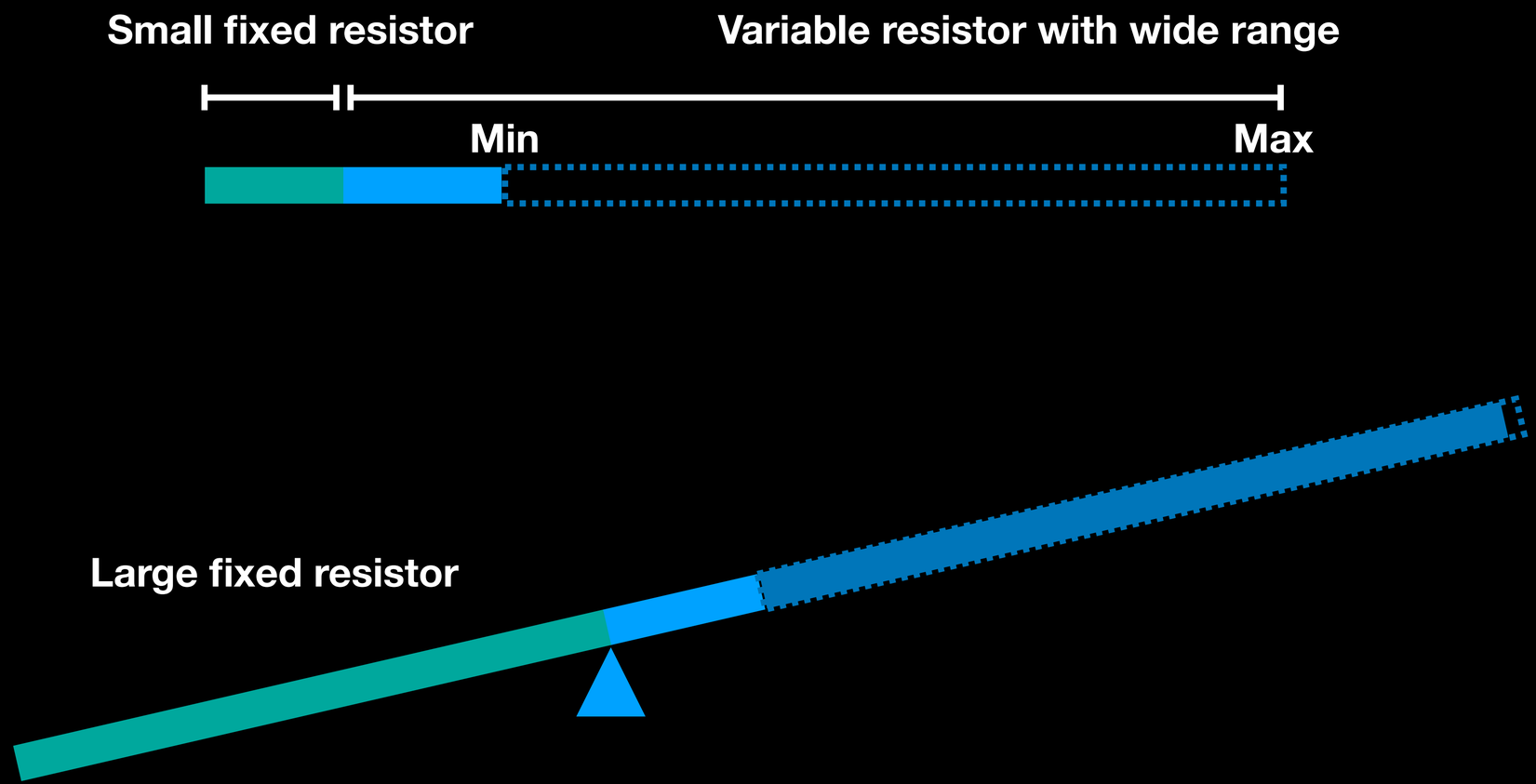



Small fixed resistor
Variable resistor with wide range
Min
Max
Example:
FSR, pressed, low resistance
Small range


Small fixed resistor
Variable resistor with wide range
Min
Max


Large fixed resistor


Small fixed resistor
Variable resistor with wide range
Min
Max
Large fixed resistor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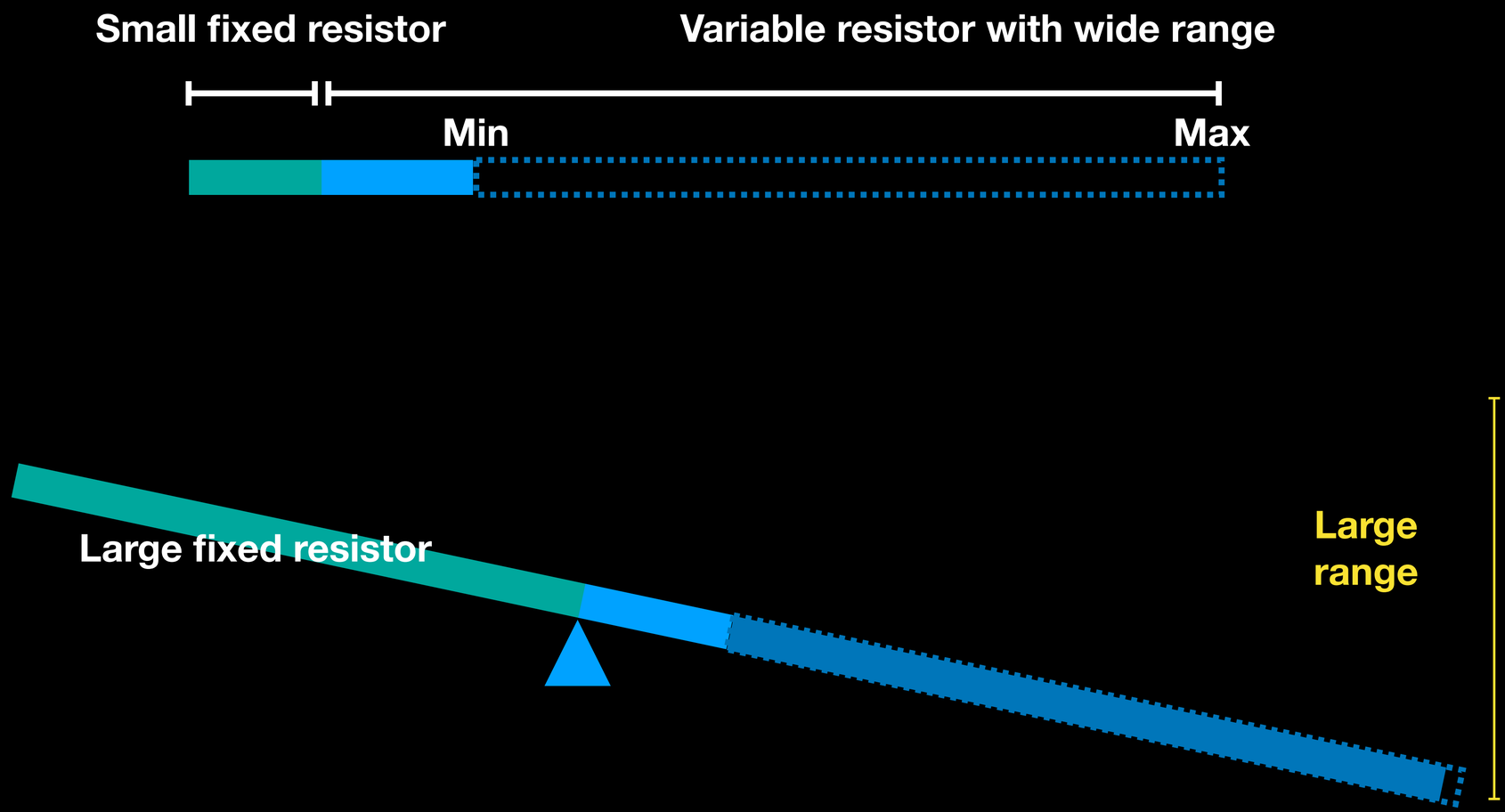
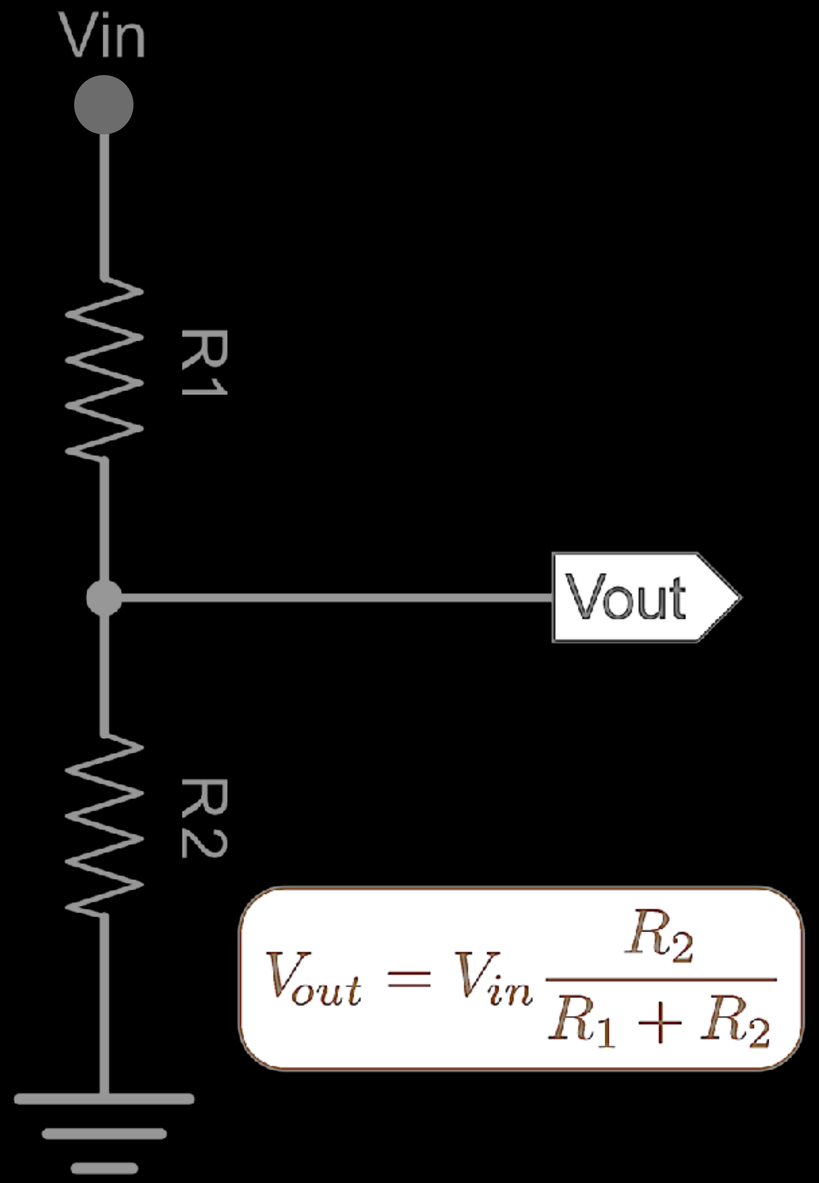

Small fixed resistor
Variable resistor with wide range
Min
Max
Large fixed resistor
Large range

Voltage divider circuit



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

image: openclipart.org

Voltage divider circuit

Dot, squiggle, squiggle, bar

Each squiggle is an R

The ratio R1 to 2

Determines what Vout will do

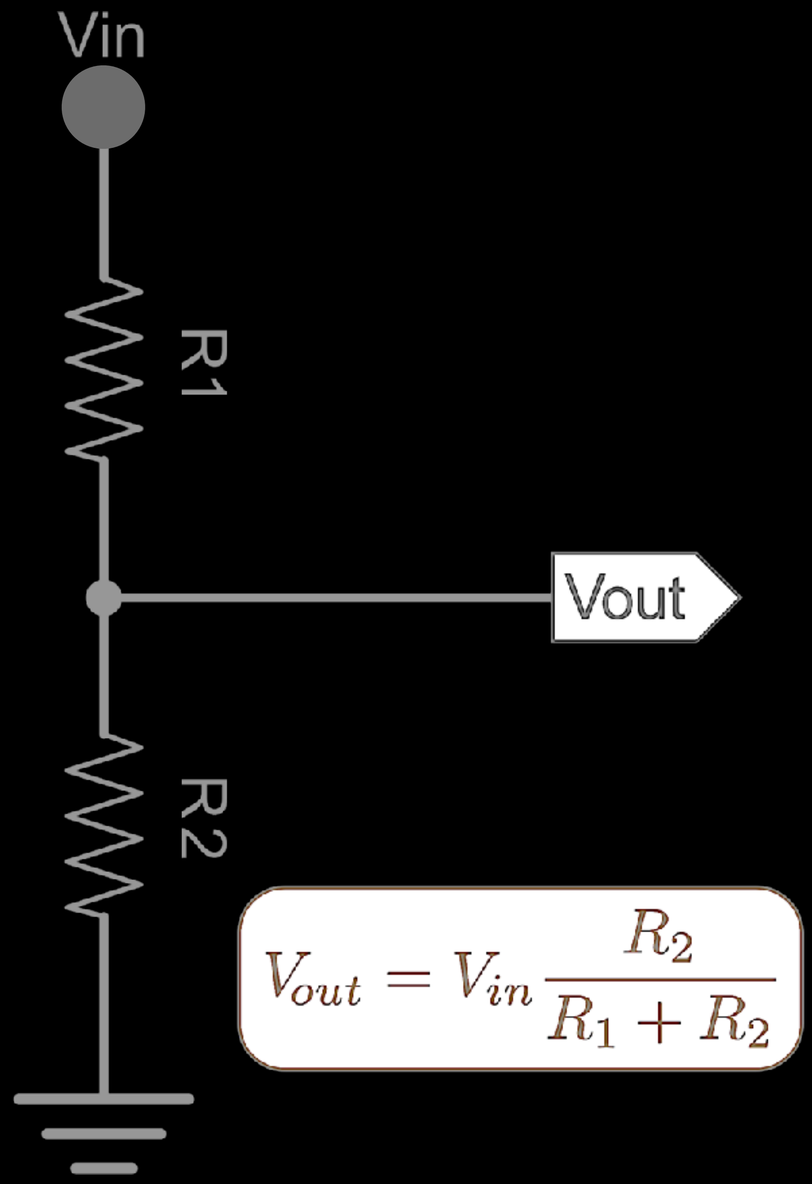


image: openclipart.org

(Psst: Tidy circuits work better)