

# 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!

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

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.

(Also: When charges move, they create magnetic fields; When magnetic fields change, they exert forces on electrons. Hence, we talk about "electromagnetism" or "electromagnetic waves"; these are intertwined phenomena.)

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



- 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





- 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,  $\Omega$ .**

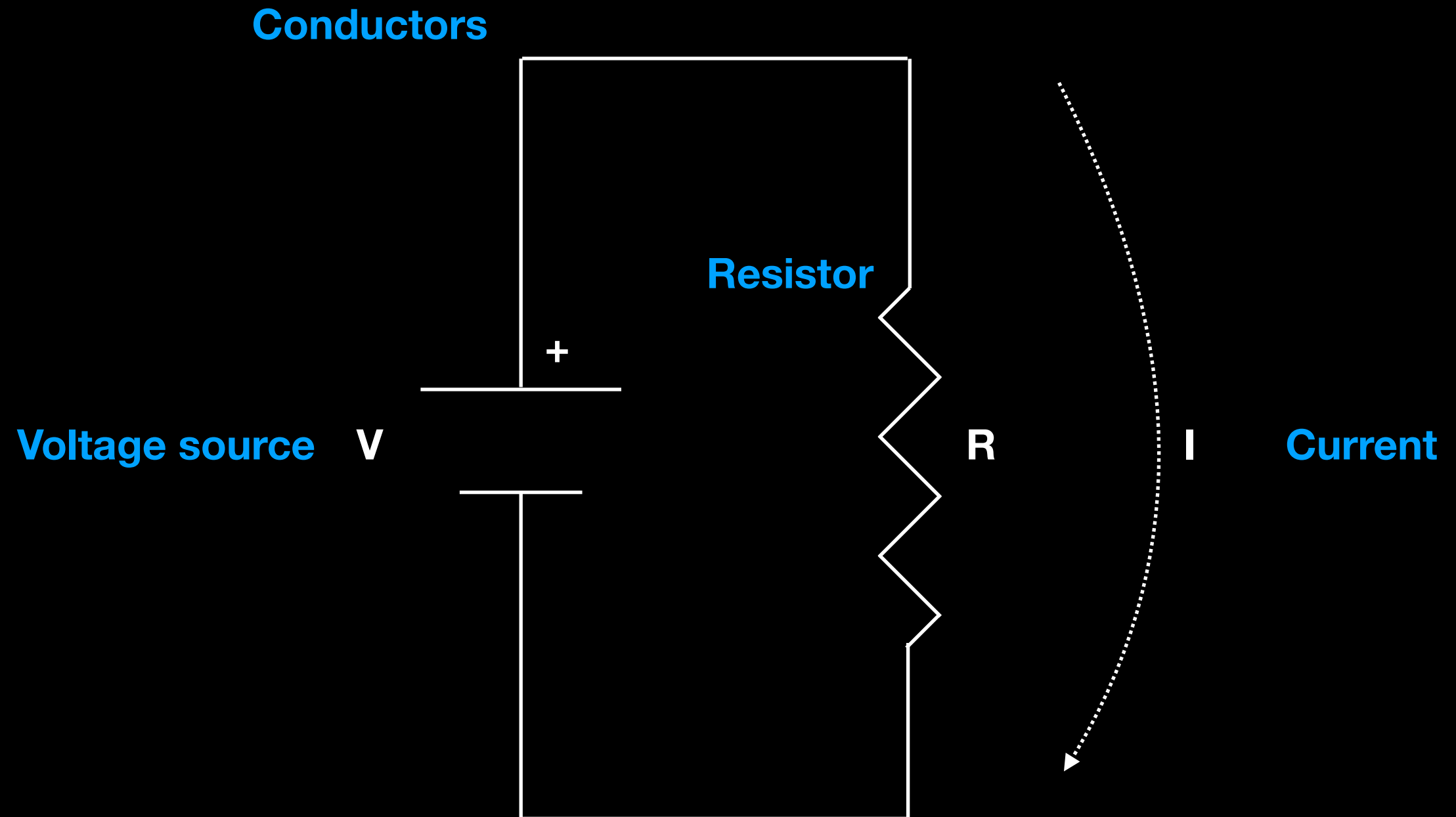
- Voltage is measured between two points, and every (DC) power supply has a positive and negative (or positive and “GROUND”) side.
- The path from positive to negative, through some stuff, is called a CIRCUIT.
- Flowing charge is called CURRENT, measured in Amps (A) and noted in circuits as “I”

- 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:

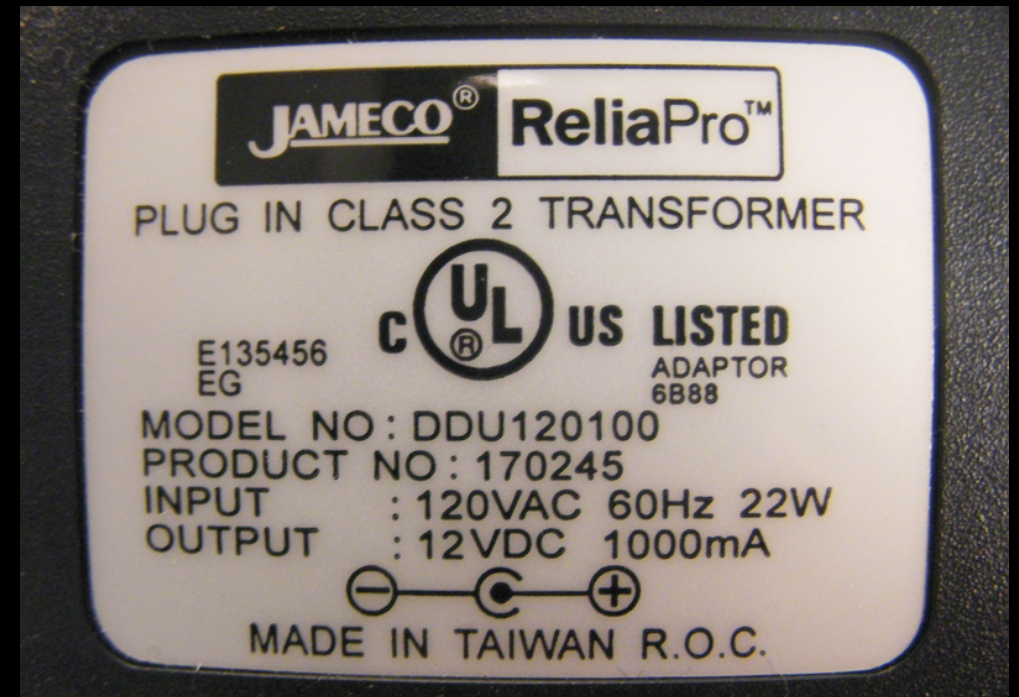
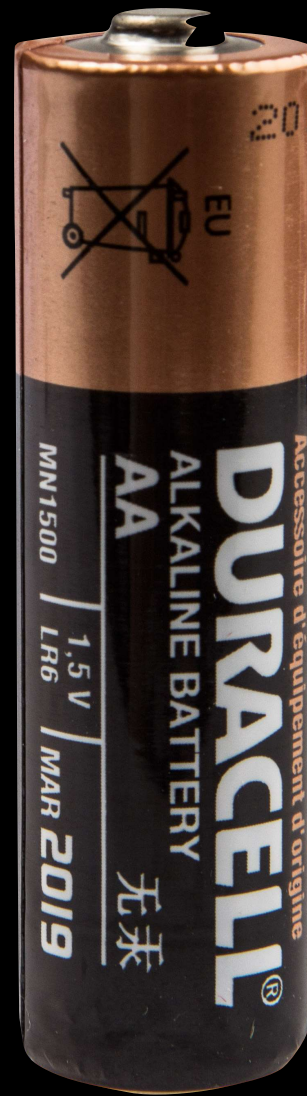
$$I = V/R$$

We can show this symbolically:



Our goal today is to build the foundation for the Labs you will do in the coming weeks. We will:

- Use a power supply to get 5V for prototyping circuits
- Set up a breadboard
- Use a multimeter to make measurements of Voltage and Resistance
- See some basic components and their schematic symbols
- Do a soldering demo



For any electrical power supply ask:

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

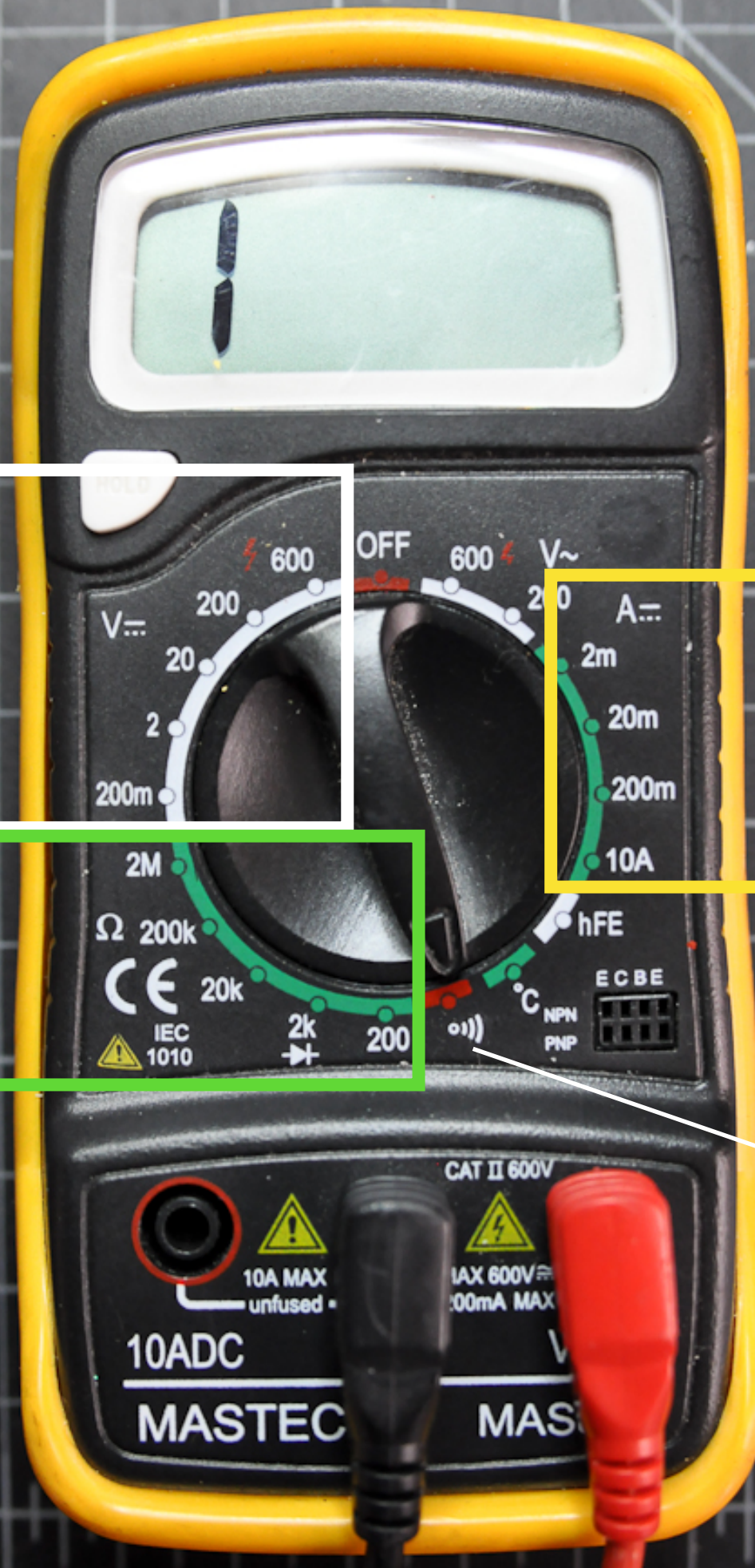


DC Volts

DC Current

Resistance

Continuity



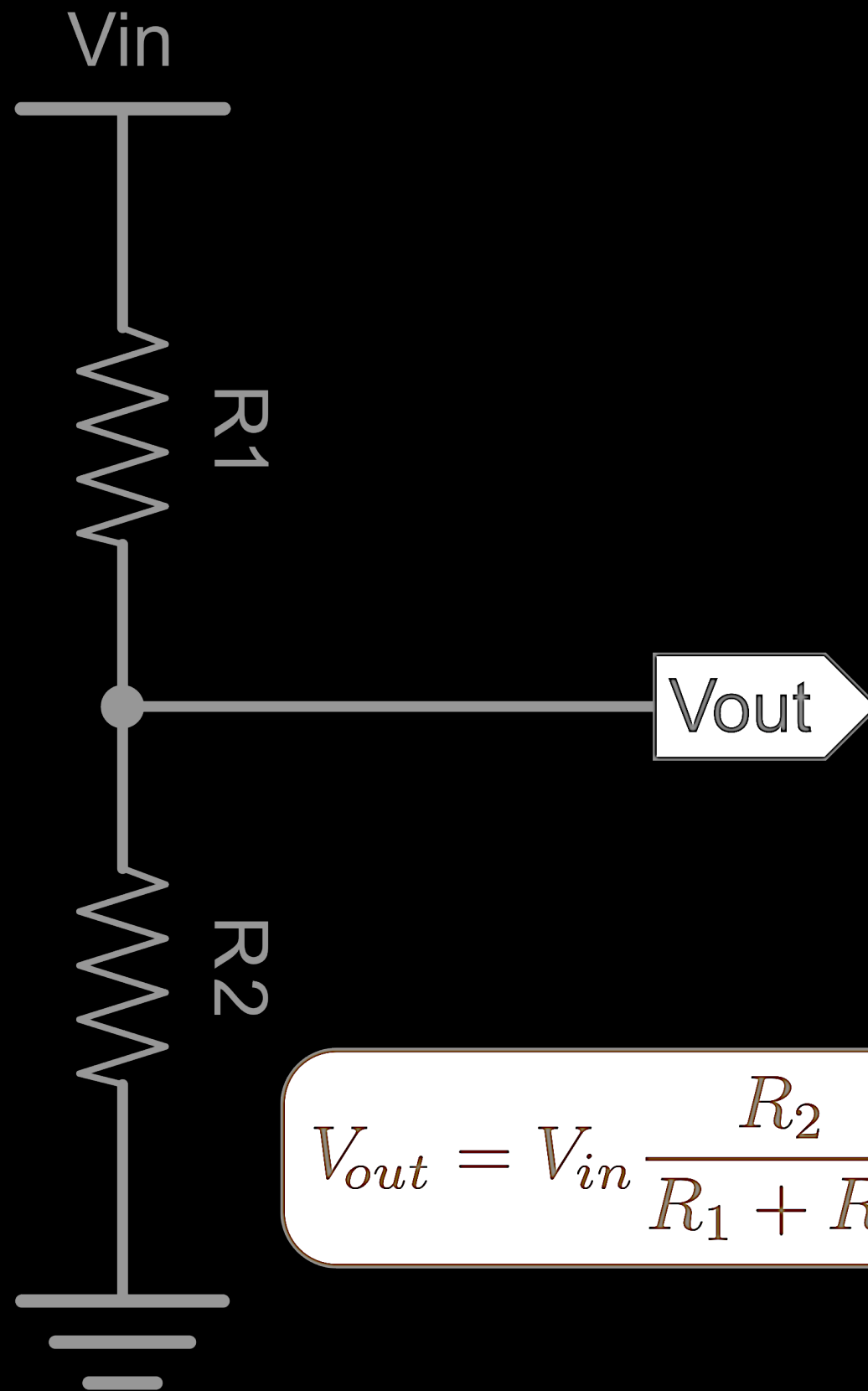


# Everything important about electricity\*

- 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

# Voltage divider circuit



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