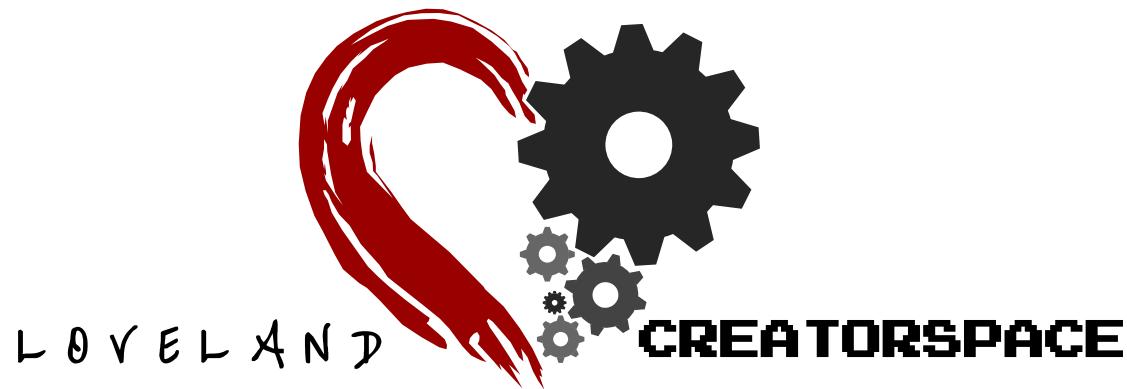


# Introduction To Electronics

A practical introduction to  
common electronic components and circuits



# Overview

- Concepts – Circuit, Current, Voltage
- Basic Components
- Build simple circuits
- Experiment with components

# Level Of Detail

- Brief description of theory
  - Nothing too heavy
  - Plenty of opportunity for follow-on presentations or hands-on coaching
- Practical familiarity with components
  - Pick them up and look at them a bit later
- Practical experimentation
  - Hopefully you'll get an intuitive feel for what the components do

# What Is A Circuit?

- A closed loop through which electrical current can flow  
*(What's current? Next page...)*
- The loop will contain various components  
*(We'll describe some examples later...)*
- Can be a complex network of loops, not just one simple loop

# Current - 1

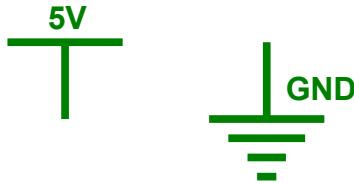
- A movement of charge carriers around a circuit
  - Those charge carriers are typically electrons
  - Similar to the flow of water in a pipe
- Measured in Amperes/Amps (A)
  - LEDs or micro-controllers use tens of mA
  - Consumer electronics use (order of) ~1-2A
  - Home appliances use (order of) 10-50A
  - Just a few mA can kill you!
    - Depending on voltage and other factors
    - Don't worry – low voltages are safe

# Voltage

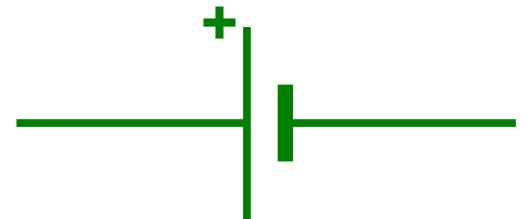
- “Electric potential energy per unit charge” (*wikipedia*)
  - Sounds complicated!
  - Potential: cf. gravitational potential energy due to height differences in a hydro-electric dam
- Think of it as the force pushing current
  - Similar to pressure in a water pipe,
- Measured in Volts (V). Typical values:
  - 5V for electronics (safe to tinker with)
  - 12V for car batteries
  - 100-250V for household mains (don't play with this)
  - Perhaps 2000kV for grid transmission lines (stay well away)

# Current - 2

- Current moves charge carriers from areas at one voltage to areas of another voltage
- This is a change in the (electric) potential energy of the charge carriers
- The gained or lost energy can be converted to/from other forms, e.g. light, heat, motion
  - This is how electronics interfaces with the world



# Voltage Sources



Batteries

Mains electricity



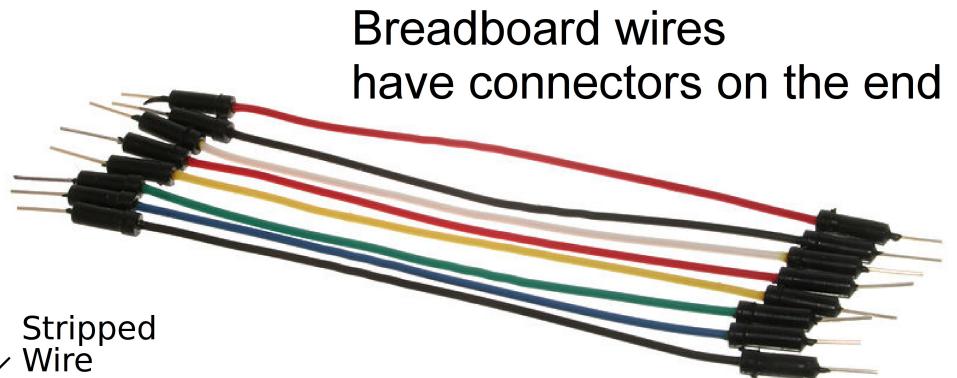
Wall Wart / Power Supply / Charger



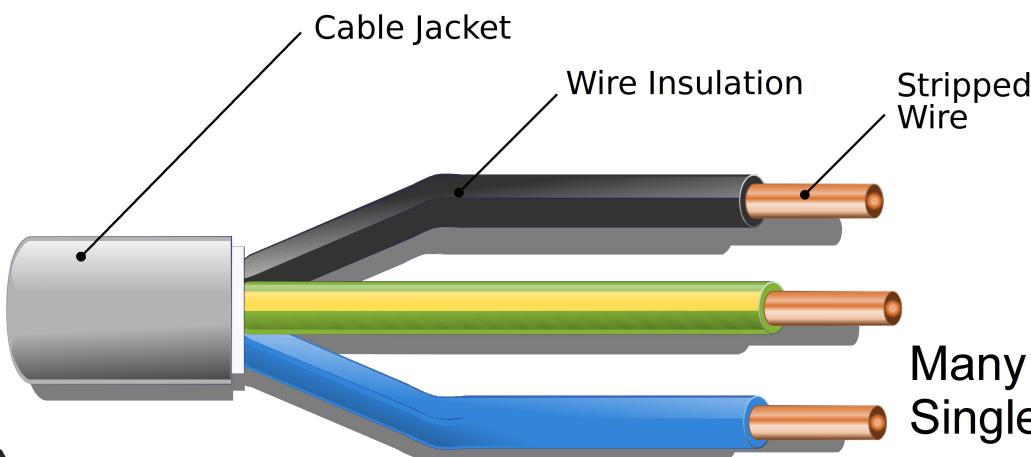
# Wires

---

- Contain lots of charge carriers (electrons)
- Carry current
- Connect components
- Also, traces on PCB



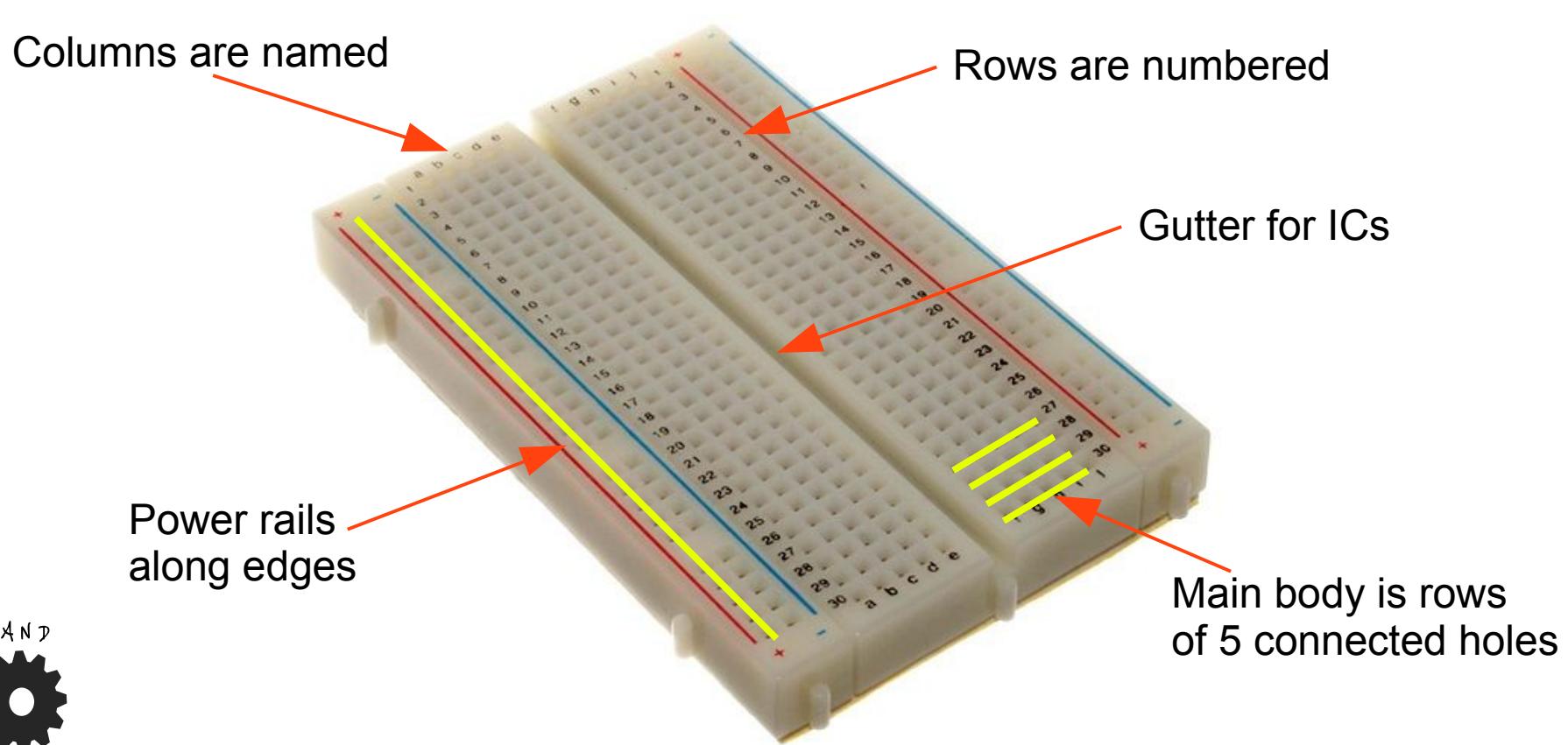
Breadboard wires  
have connectors on the end



Many different kinds of wire;  
Single/multi-core, shielded/not, ...

# Breadboards

- Used for quick circuit prototyping
- Holes to plug components' wires into
- Internal wires connect some of the holes



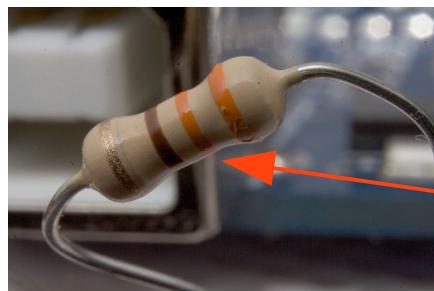


# Resistors - 1



- Restrict the flow of current through a circuit
- Non-polarized: 2 identical terminals (wires)
- Value measured in Ohms ( $\Omega$ )
  - Typical values zero to millions of Ohms
- Ohm's law:
  - $V = IR$
  - A voltage of 1V across a resistance of 1 $\Omega$  causes 1A of current to flow through it
  - Conversely, *if* a current of 1A flows through a resistor of 1 $\Omega$ , there is a 1V voltage drop across the resistor

# Resistors - 2



Common low-power resistor

Value represented by color bands



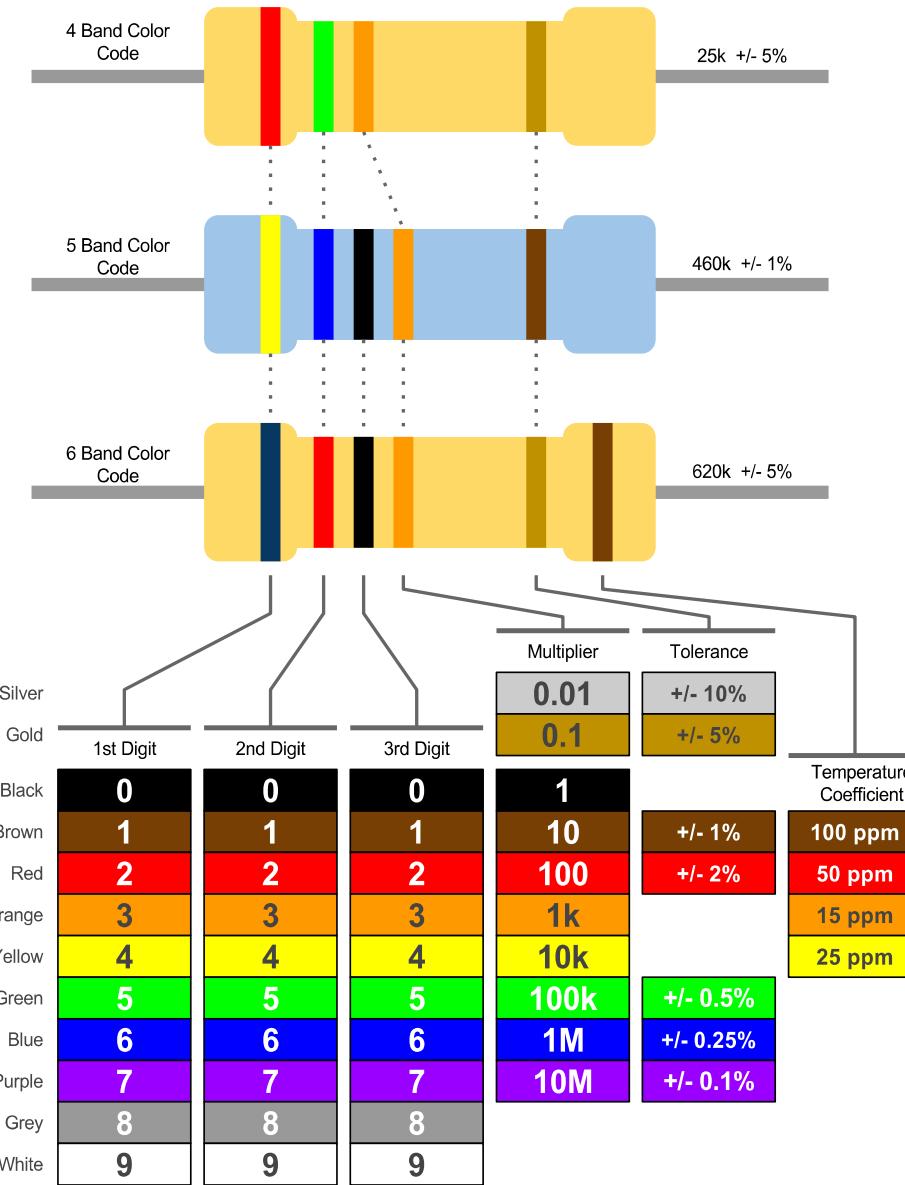
High power resistor

Value might be written as text,  
possibly coded

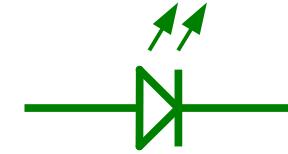


Multiple resistors in one package

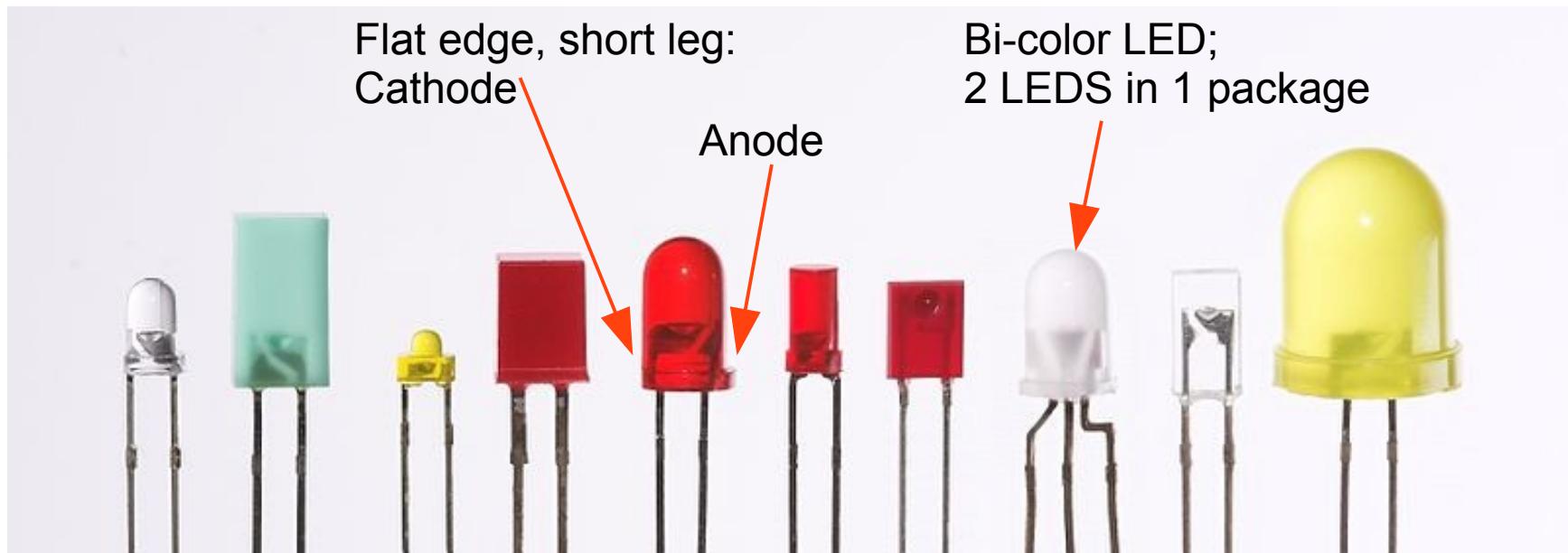
# Resistors - 3



# LEDs

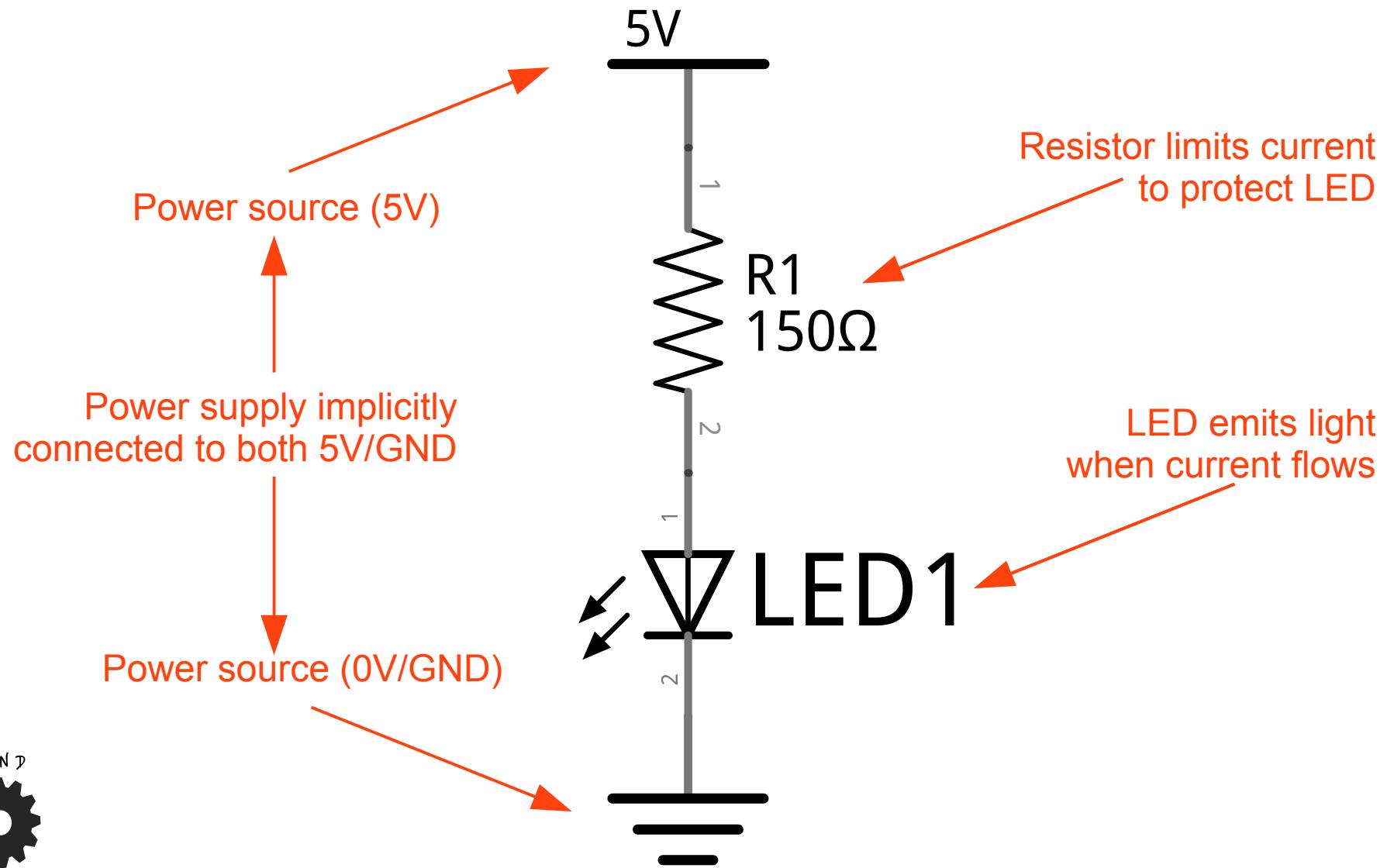


- Emit light when current flows through them
- Polarized; two terminals are different
  - Anode: Connect to more positive voltage
  - Cathode: Connect to more negative voltage



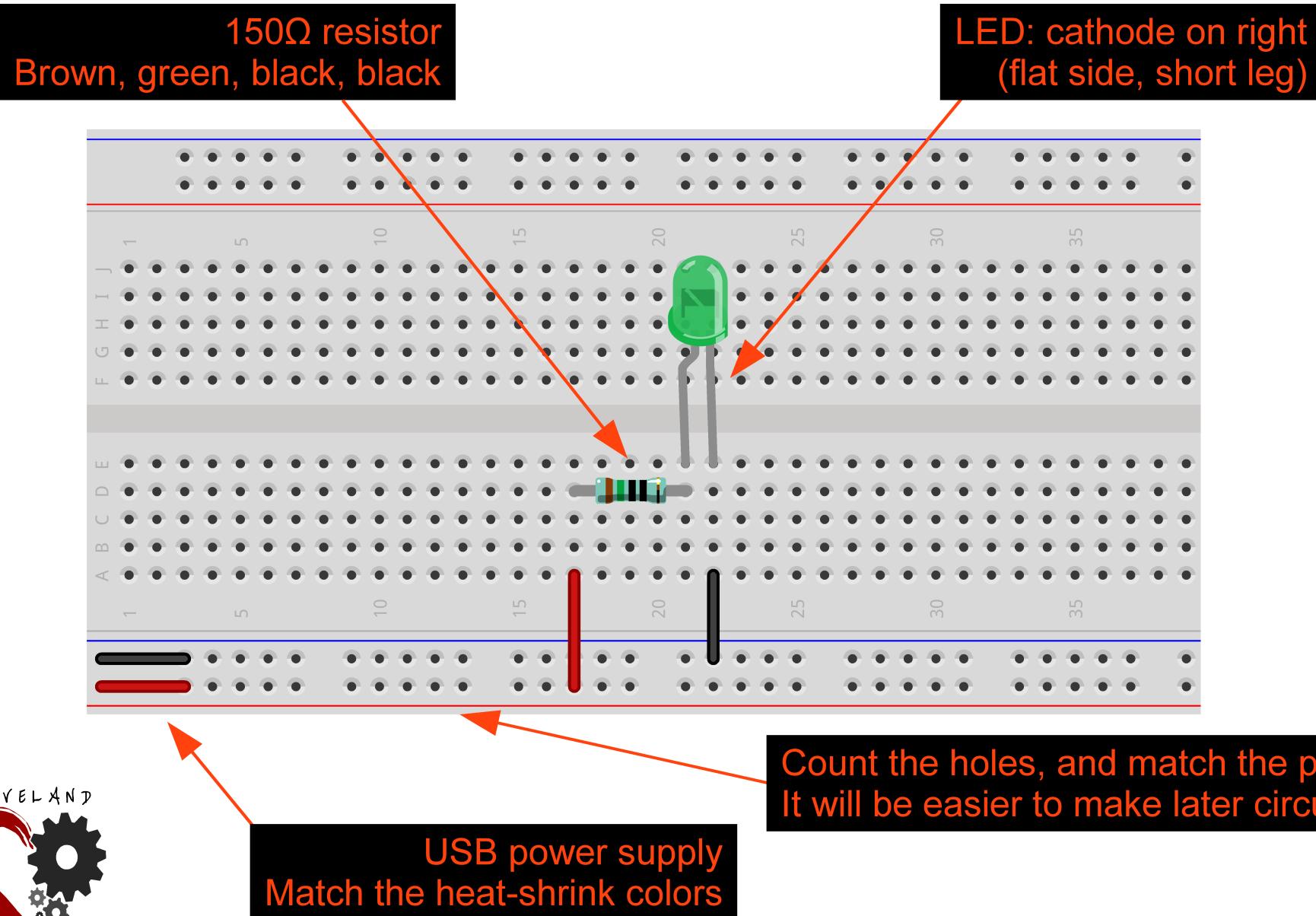
# A Simple Circuit

## Schematic



# A Simple Circuit

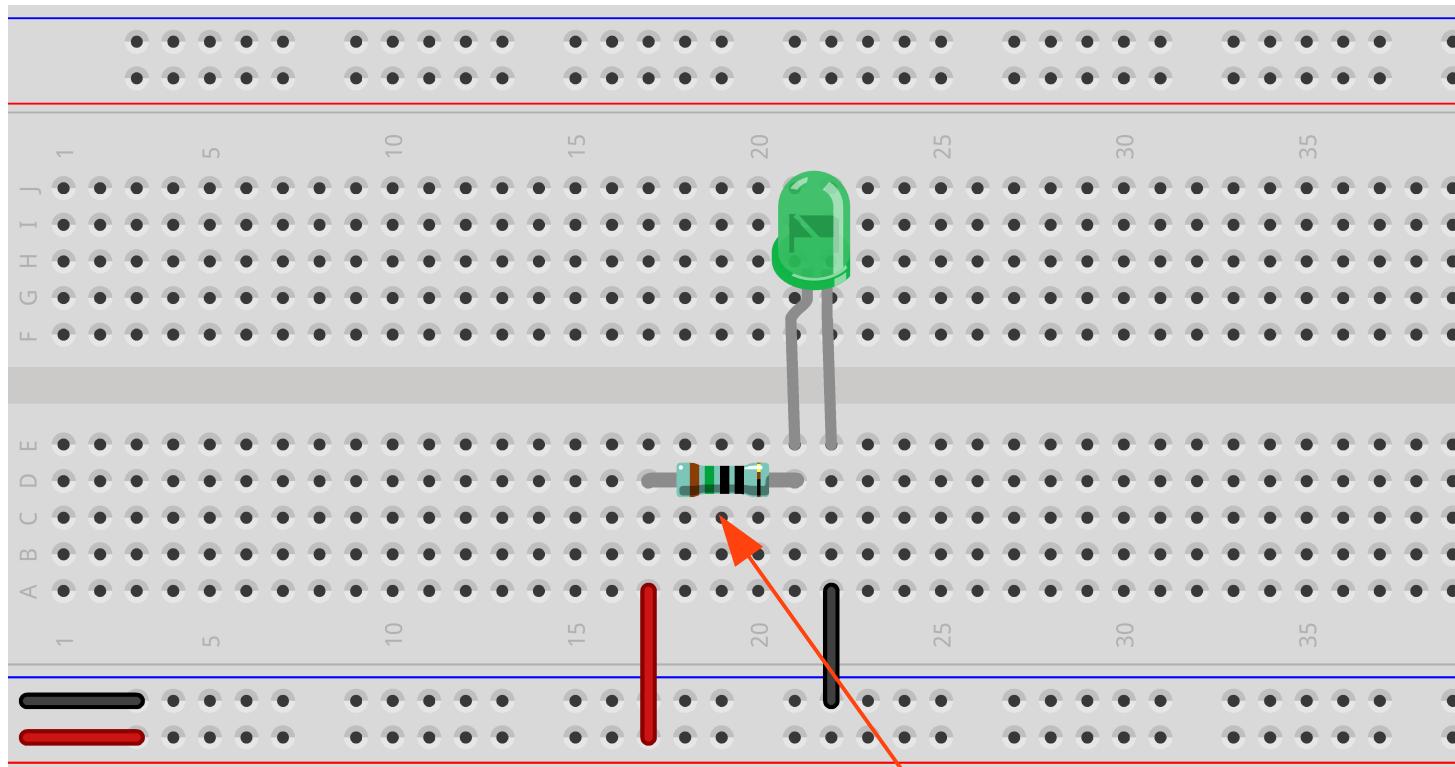
## Breadboard



# Different Resistor Values

## Breadboard

Does the LED light at all?  
(look very closely, in darkness, to check)



Change to 10k $\Omega$  resistor  
Brown, black, black, red

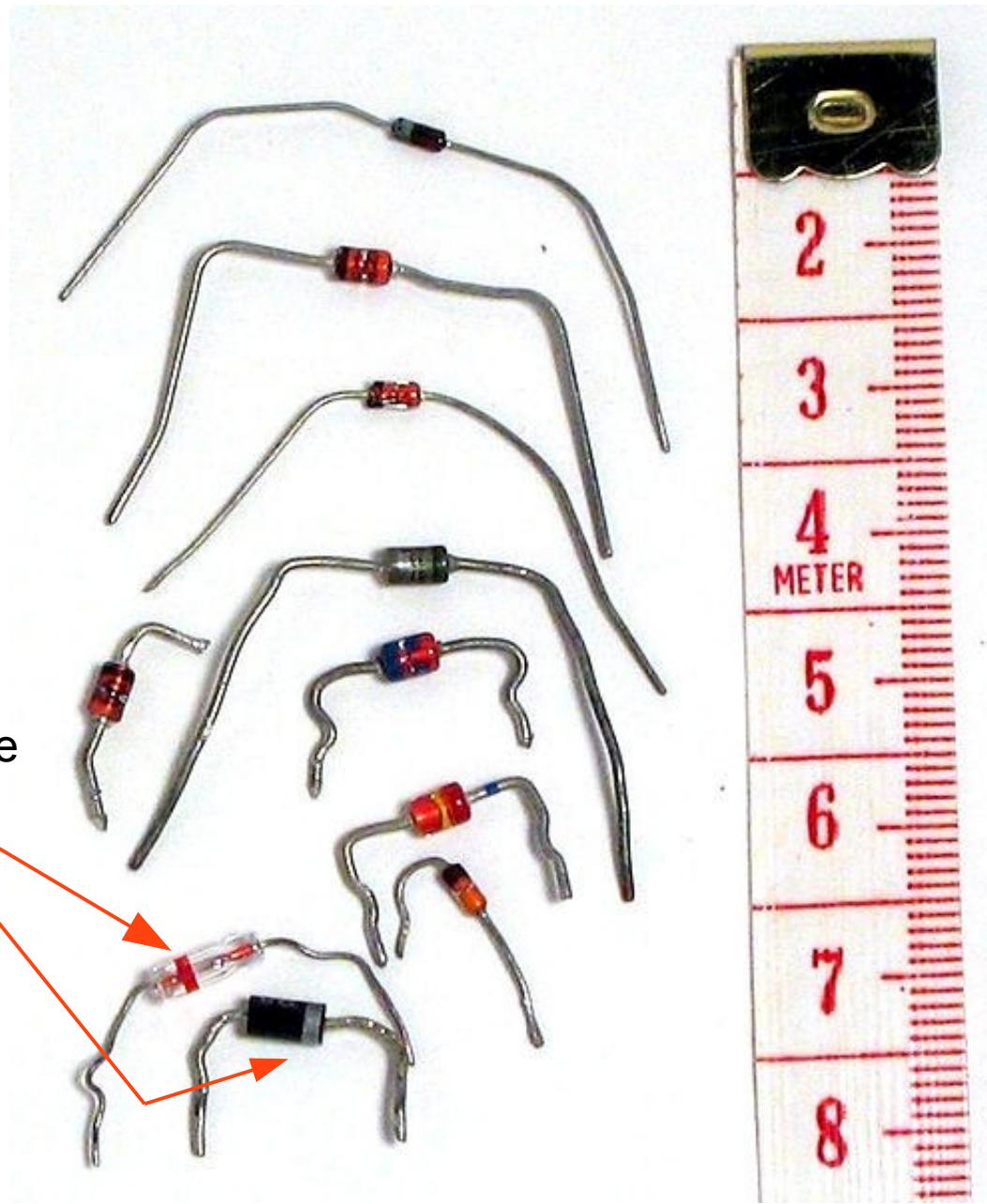
# Diodes - 1



- Allow current to flow in one direction
  - Cause a slight voltage drop as the current flows
- Block current flowing in the other direction
  - If reverse voltage gets too high,  
break down and current still flows
- Polarized; two terminals are different
  - Anode & Cathode
  - Current can flow from anode to cathode
  - LED is a Light-Emitting Diode

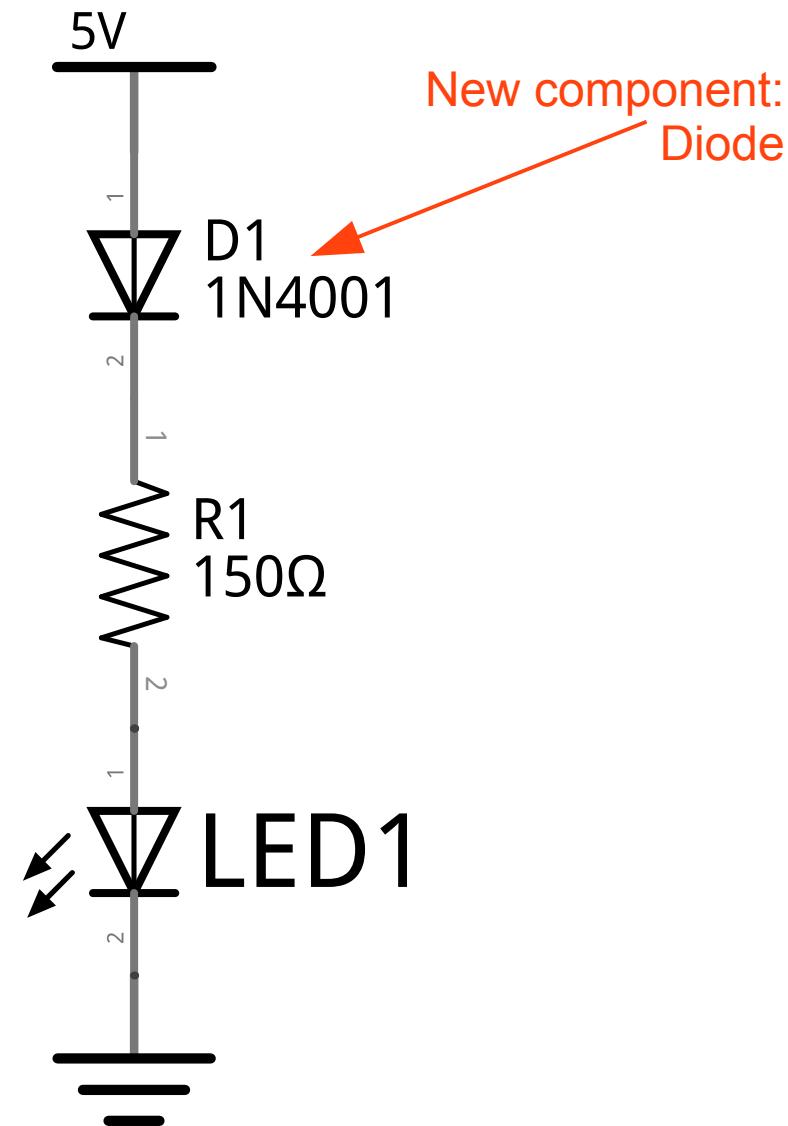
# Diodes - 2

Stripe at cathode



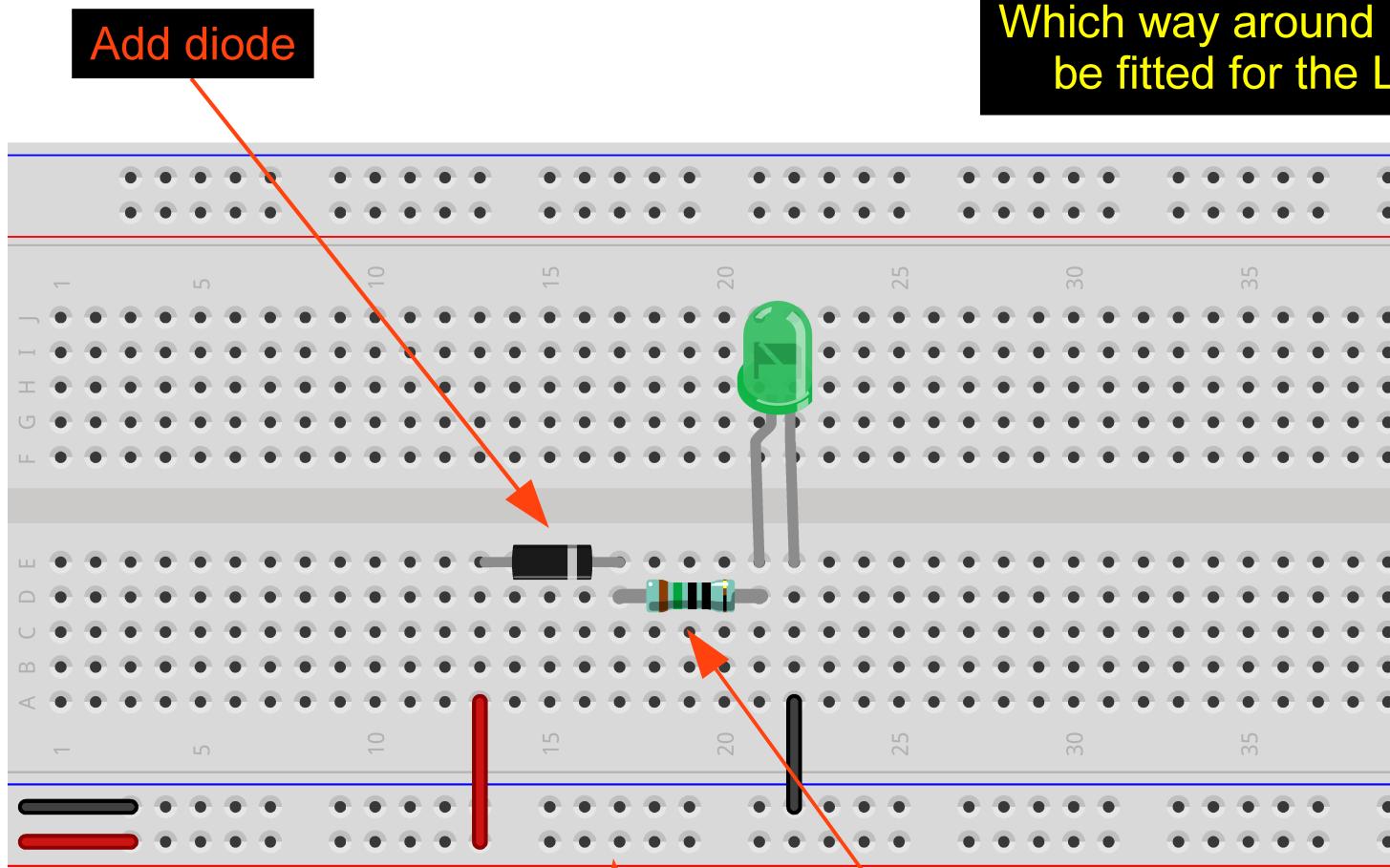
# Diodes

## Schematic



# Diodes

## Breadboard



Which way around must the diode  
be fitted for the LED to light?

Add diode

Move wire

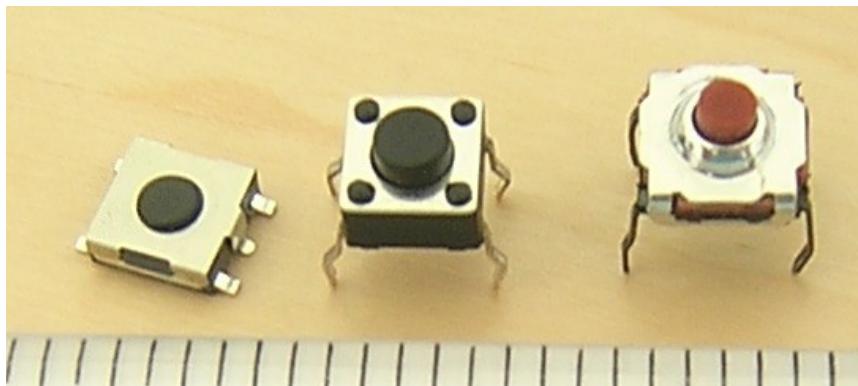
Change back to 150Ω resistor  
Brown, green, black, black



# Switches

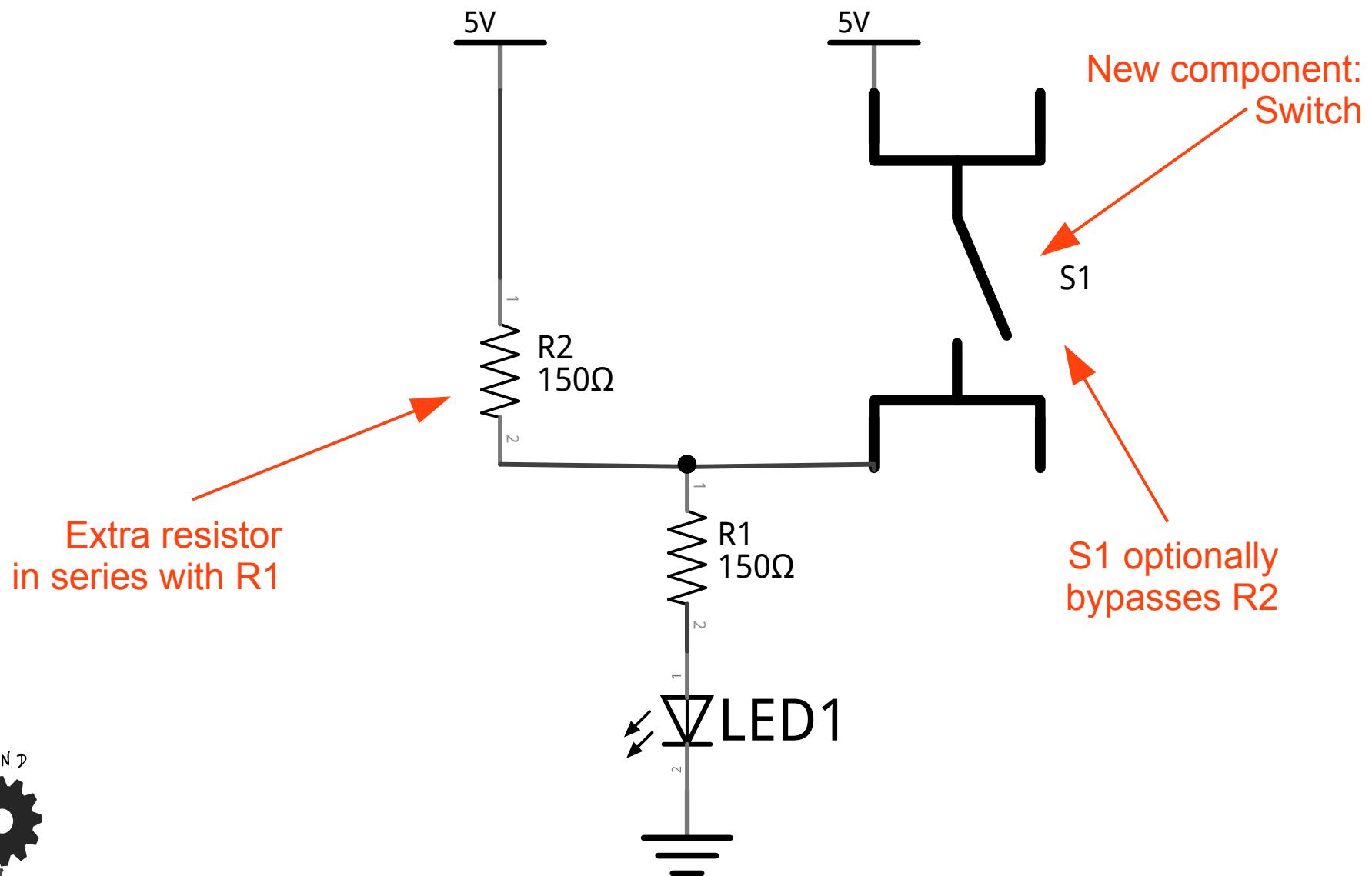


- Connect (or not) their terminals based on physical position of part of the switch



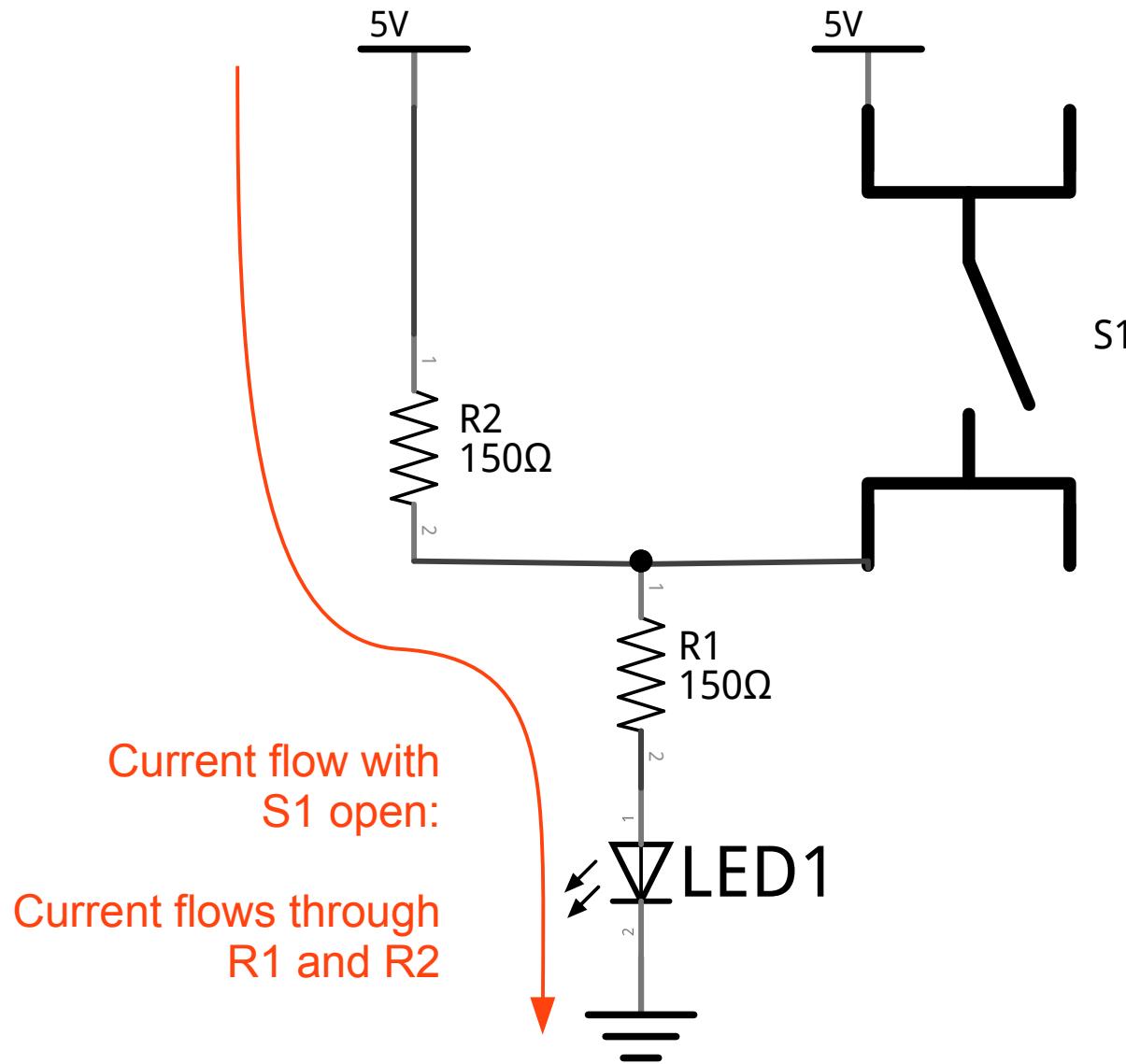
# Resistors In Series

## Schematic



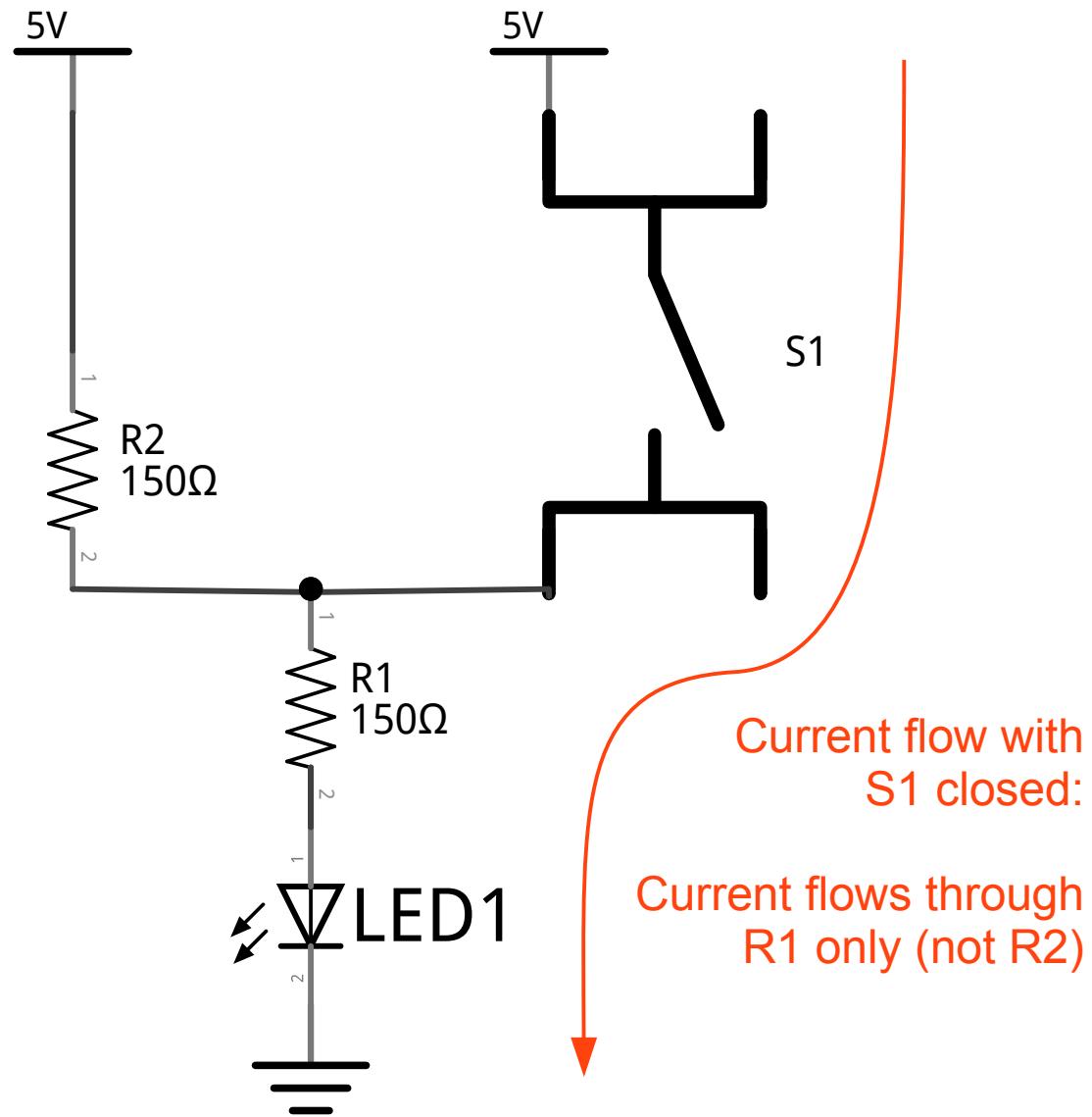
# Resistors In Series

## Schematic



# Resistors In Series

## Schematic

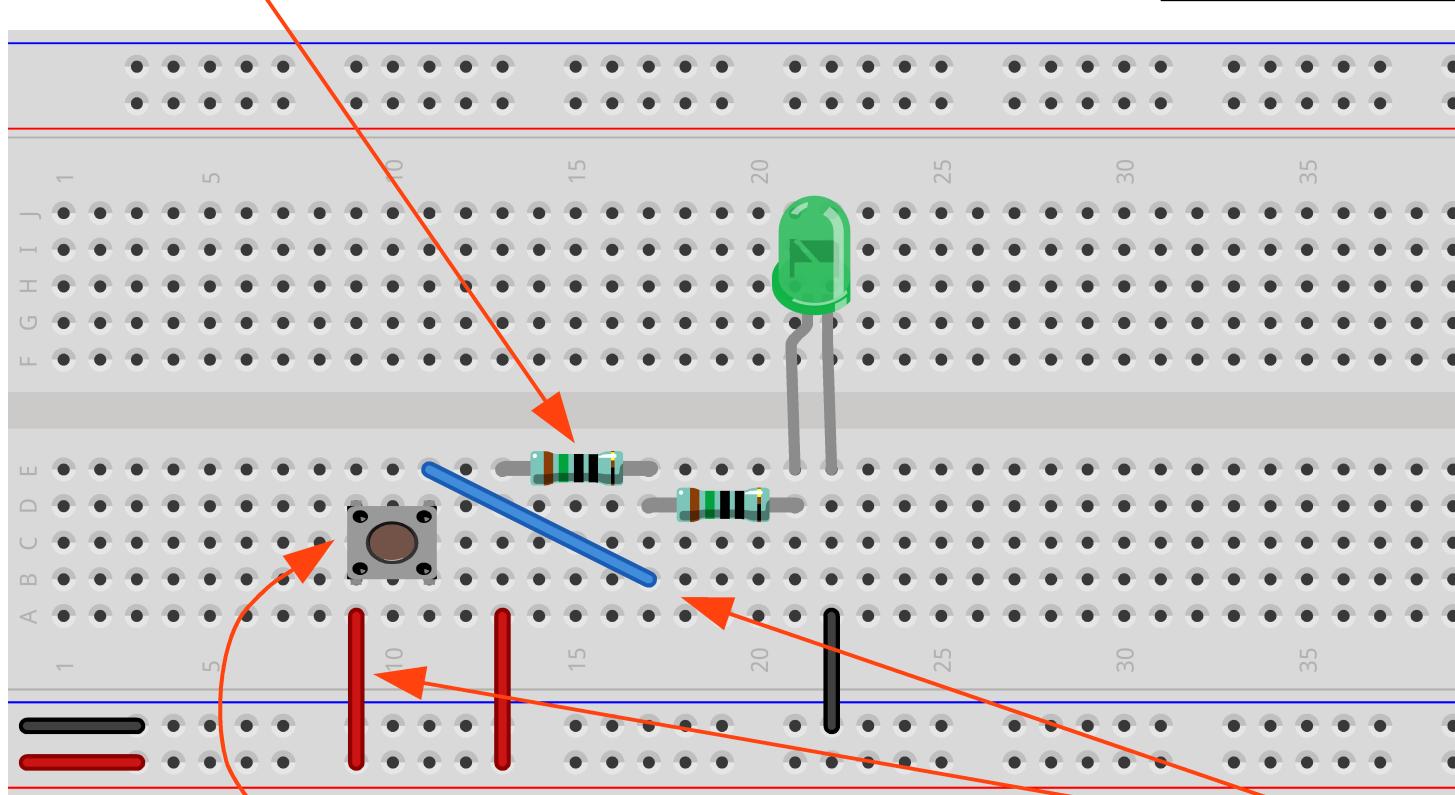


# Resistors In Series

Breadboard

Replace diode with 150Ω resistor  
Brown, green, black, black

Is the LED brighter or darker  
with the button pressed?

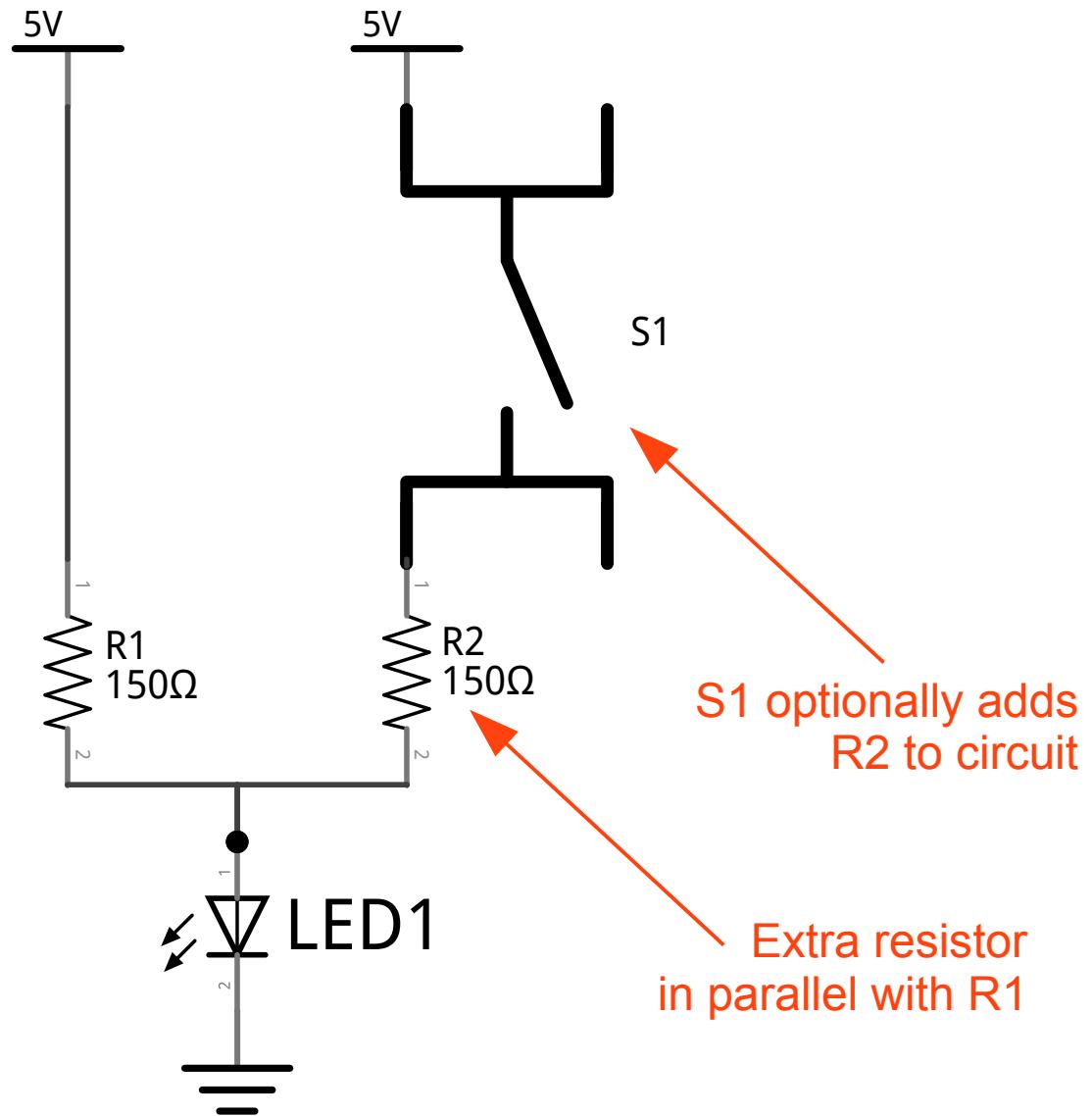


Add switch  
Legs are on top/bottom,  
not left/right

New wires

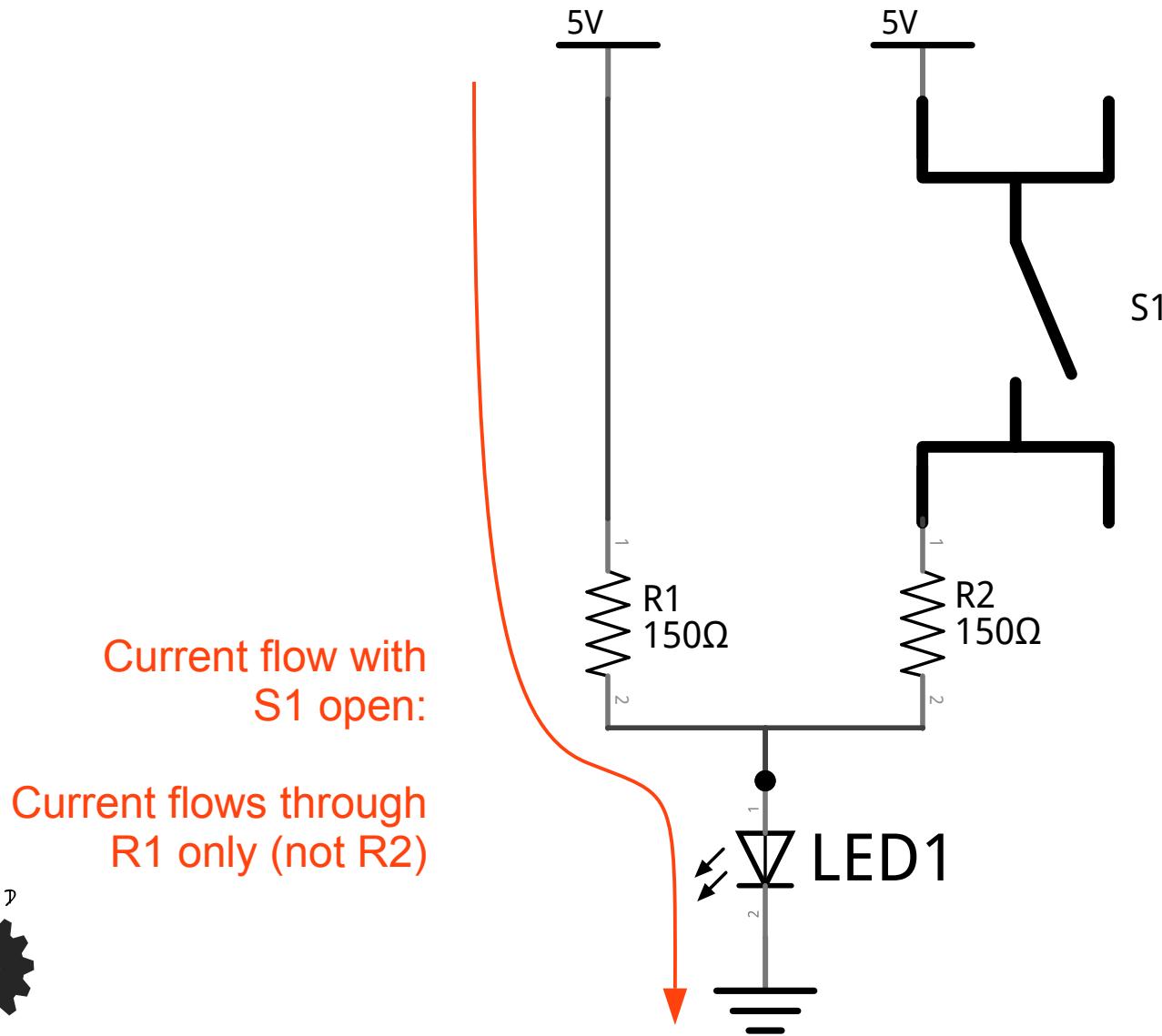
# Resistors In Parallel

## Schematic



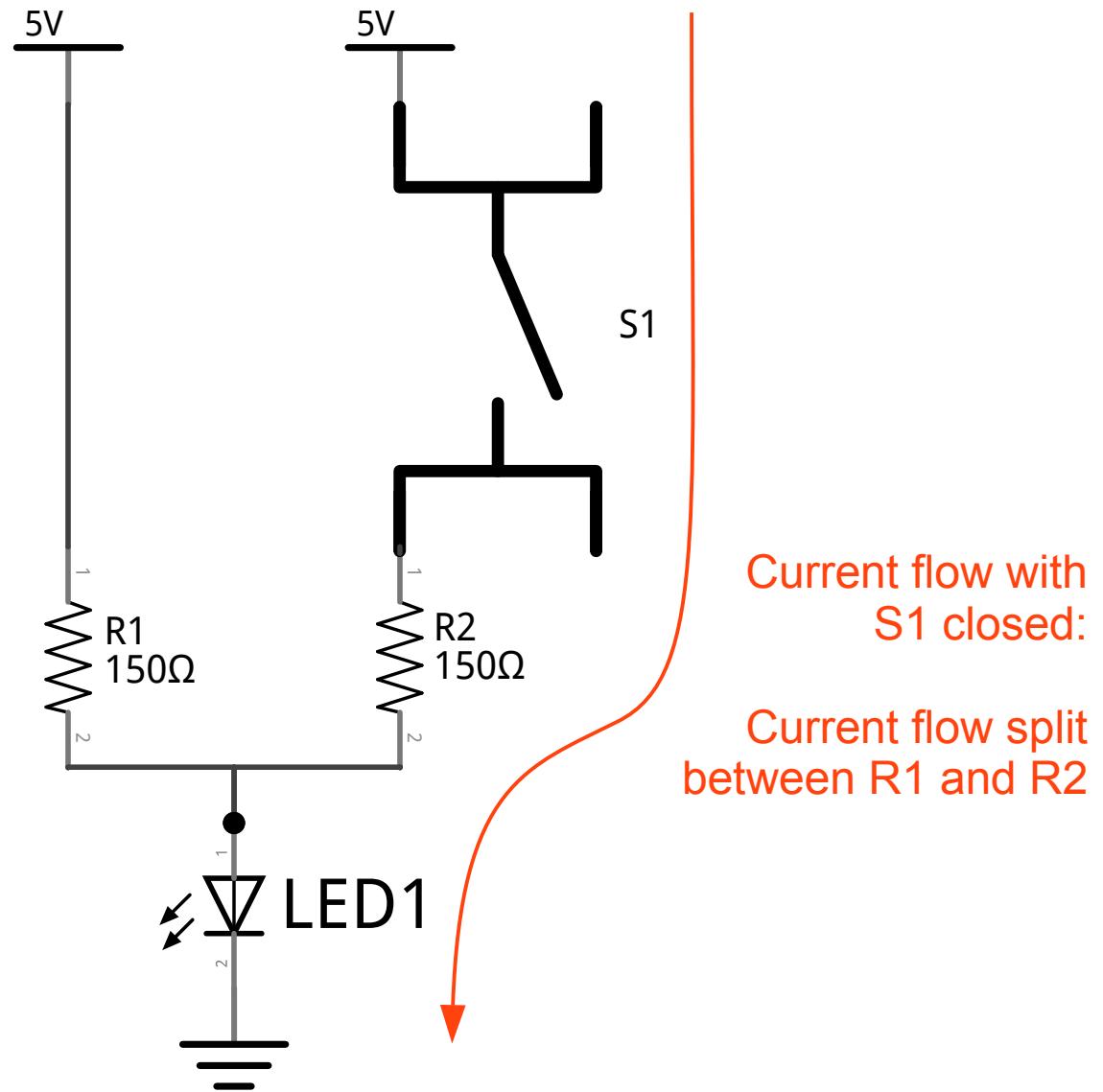
# Resistors In Parallel

## Schematic



# Resistors In Parallel

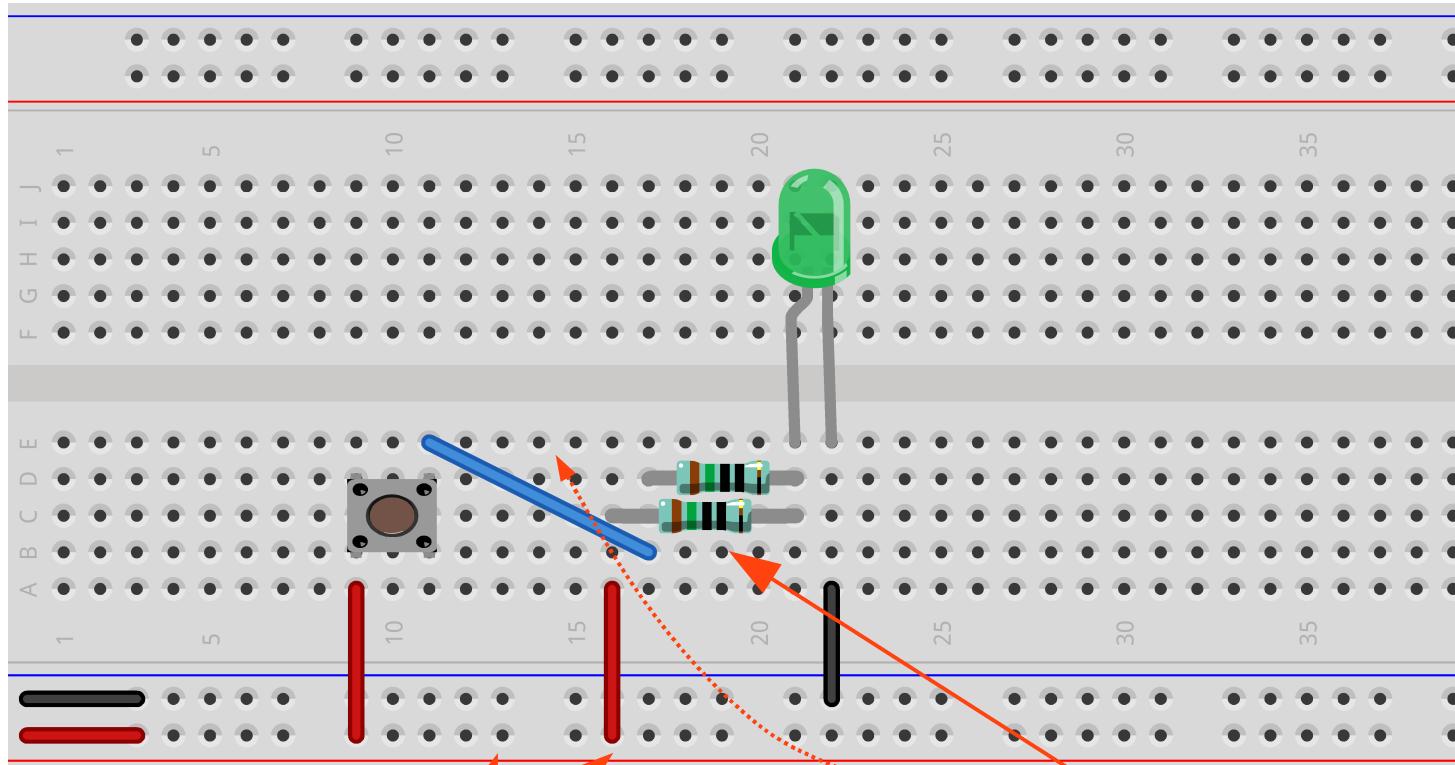
## Schematic



# Resistors In Parallel

Breadboard

Is the LED brighter or darker  
with the button pressed?



Move wire  
It aligns with nearer resistor

Move resistor  
It straddles 4 holes,  
not 3 like the other!



# Capacitors - 1



- Can temporarily store electrical (potential) energy
- Can release (or acquire) energy much more quickly, and at a higher current, than batteries
- Some are polarized, some aren't
- Value measured in Farads (F), but Farads are huge
  - Typical values  $\sim$ 10pF through perhaps 10,000 $\mu$ F
- If connected to a power source, will “charge up”
- If power removed, will discharge, and can power a circuit
- Time take to charge/discharge related to value  
useful in timing circuits

# Capacitors - 2



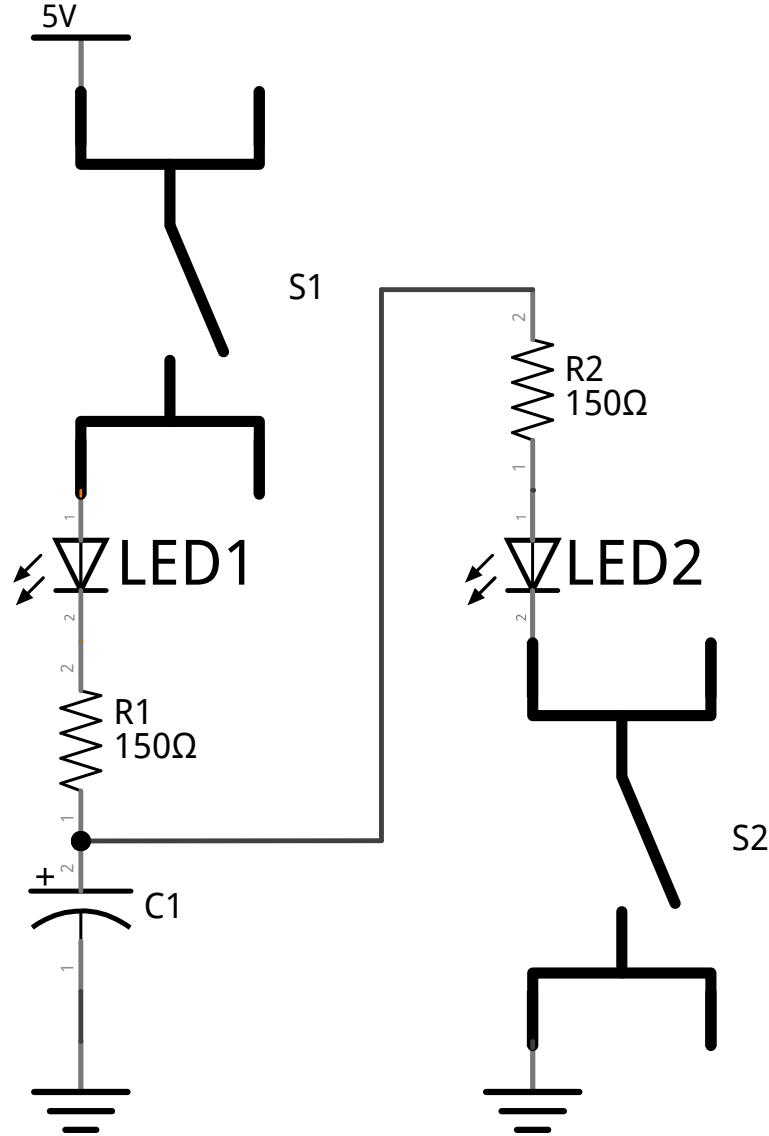
Value written as coded text



Value written as text

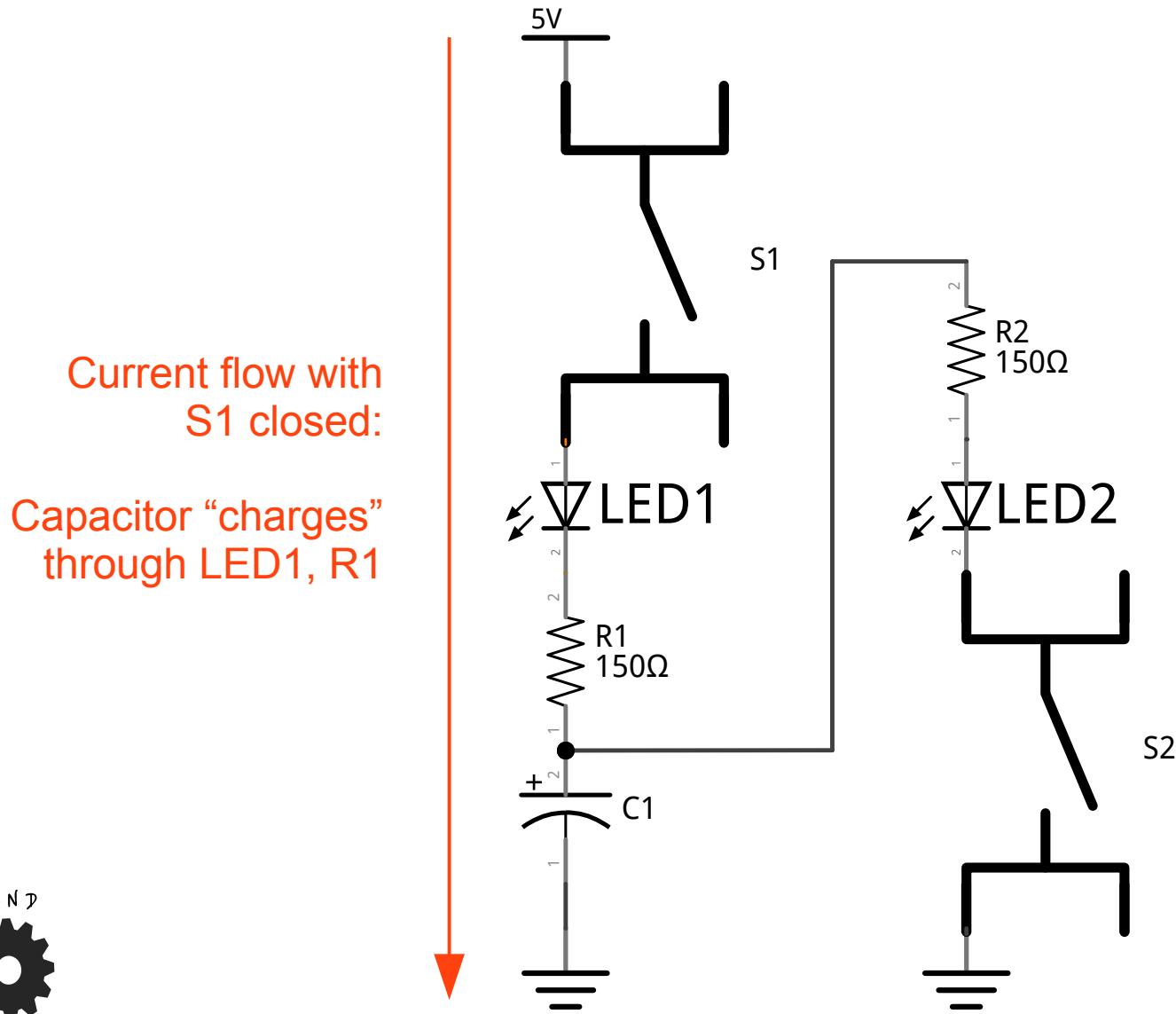
# Capacitors

## Schematic



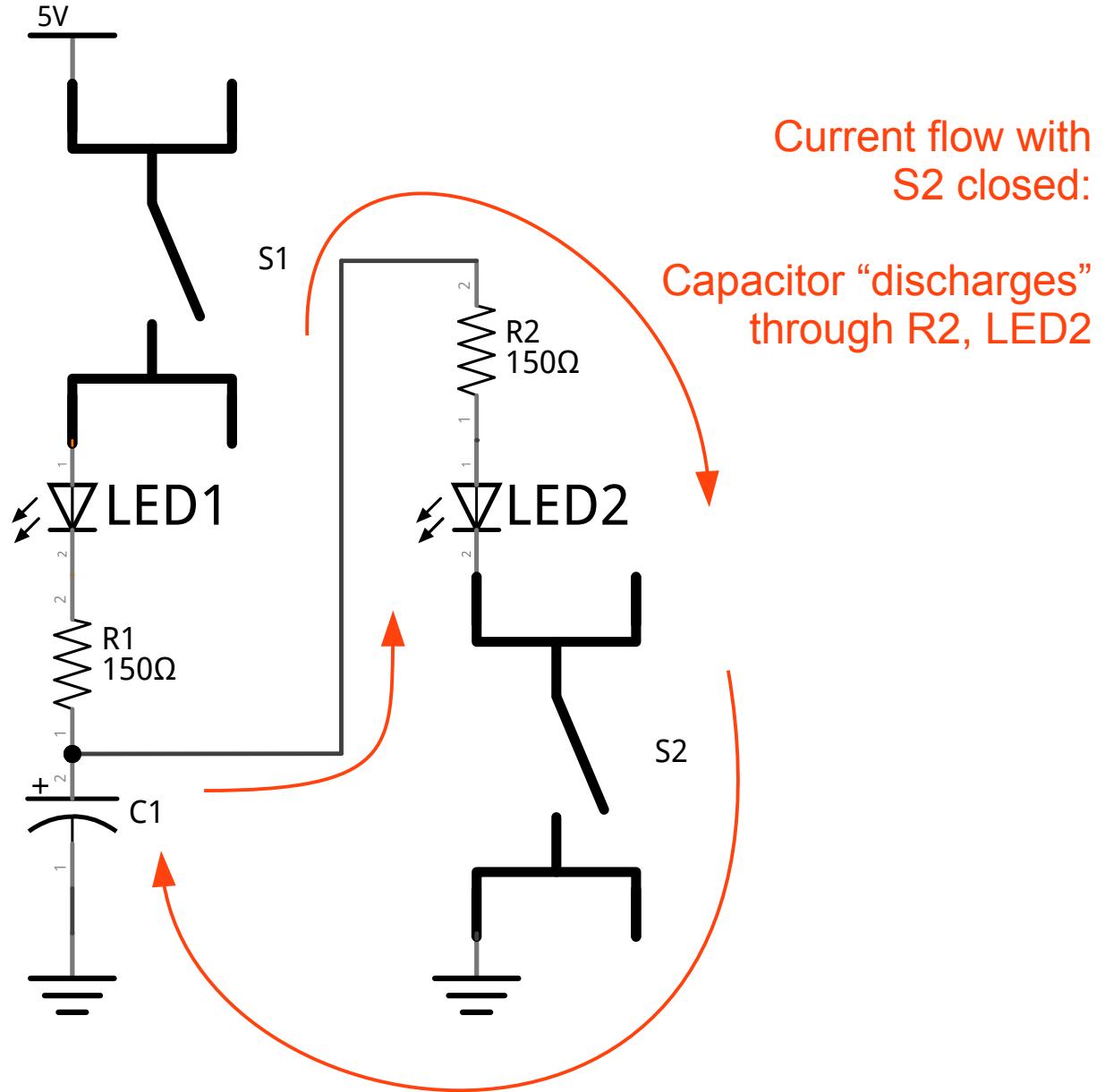
# Capacitors

## Schematic



# Capacitors

## Schematic



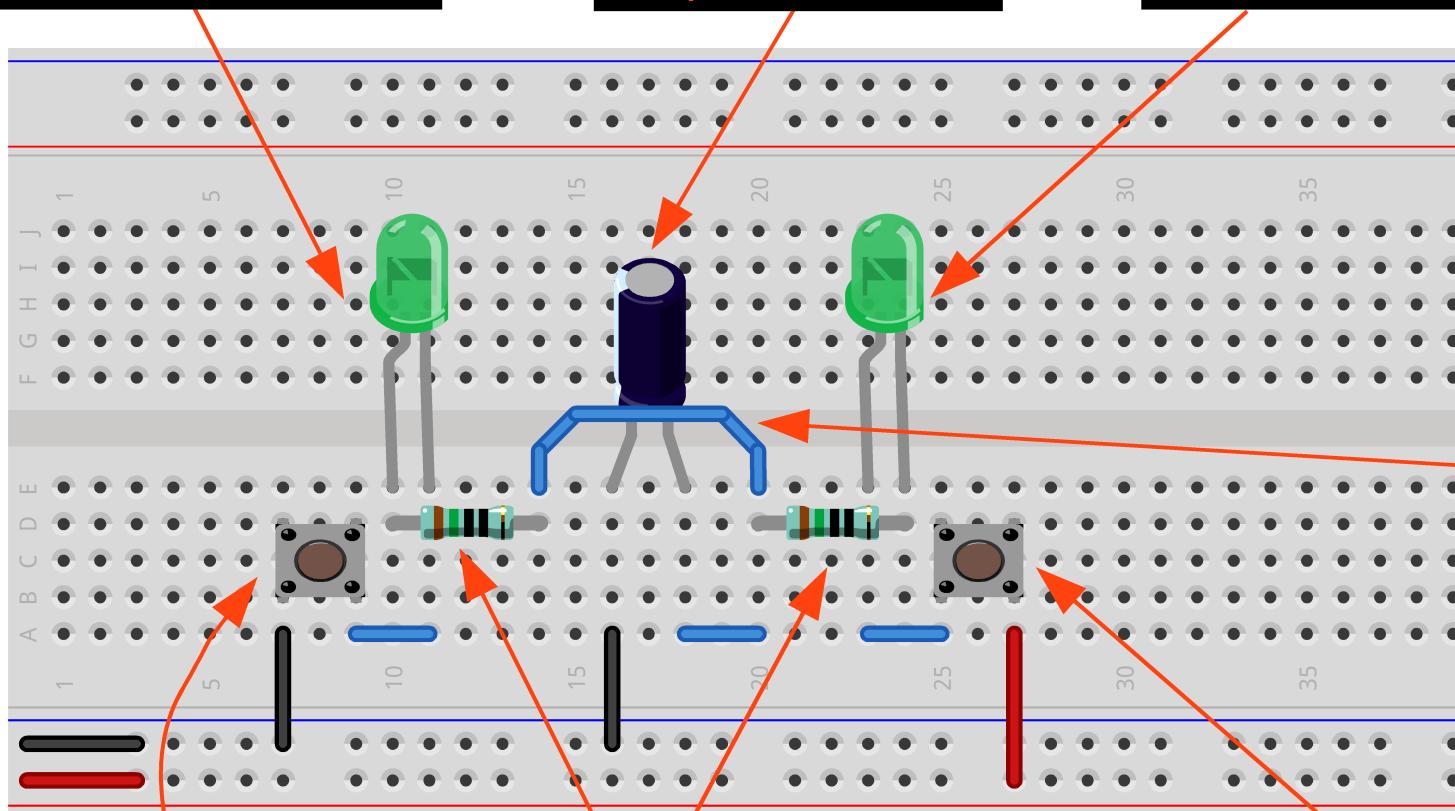
# Capacitors

## Breadboard

LED: cathode on right  
(flat side, short leg)

3300 $\mu$ F capacitor  
Stripe on left side

LED: cathode on right  
(flat side, short leg)



Wire BEHIND  
capacitor

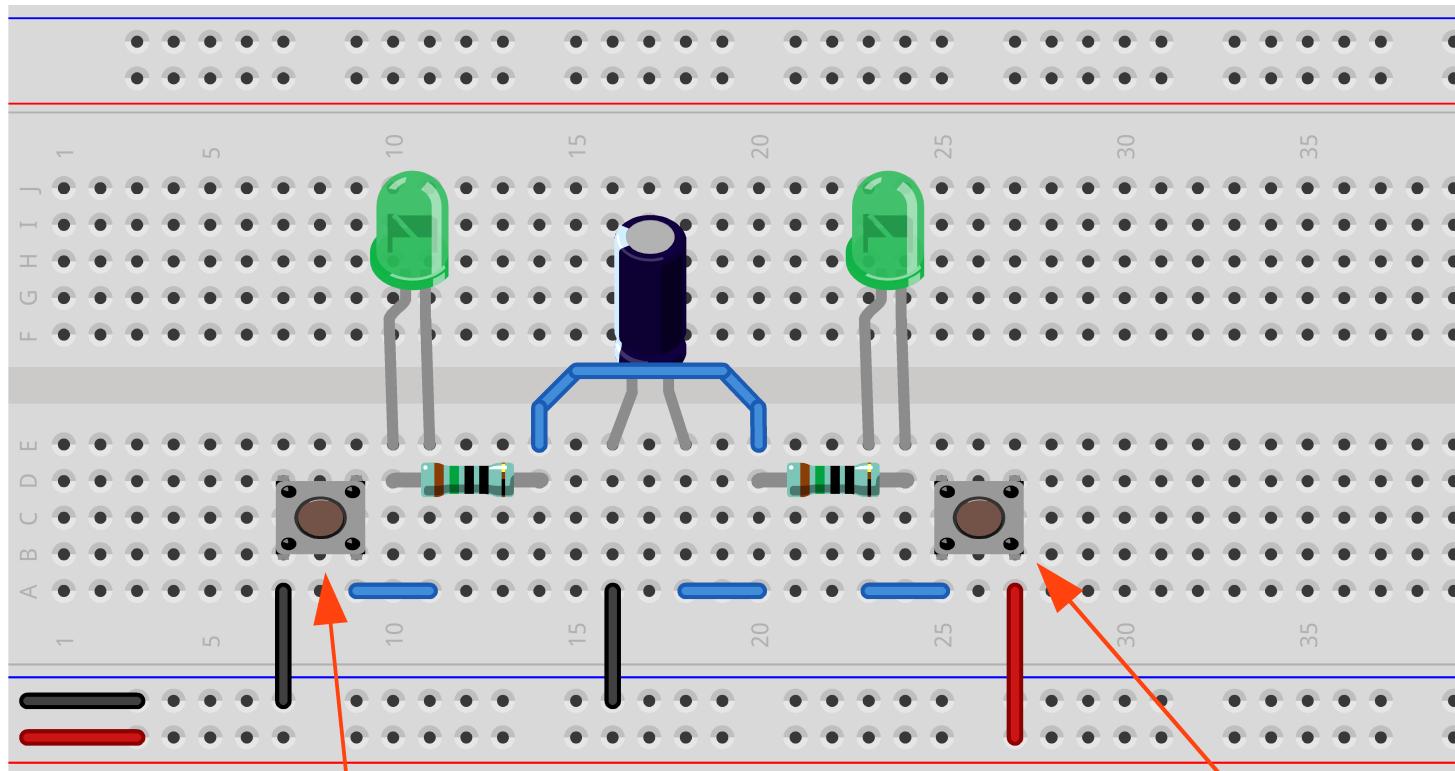
150 $\Omega$  resistor  
Brown, green, black, black

Legs on top/bottom,  
not left/right

# Capacitors

## Breadboard

How long does it take  
to charge/discharge?



Press and hold  
to “discharge” capacitor

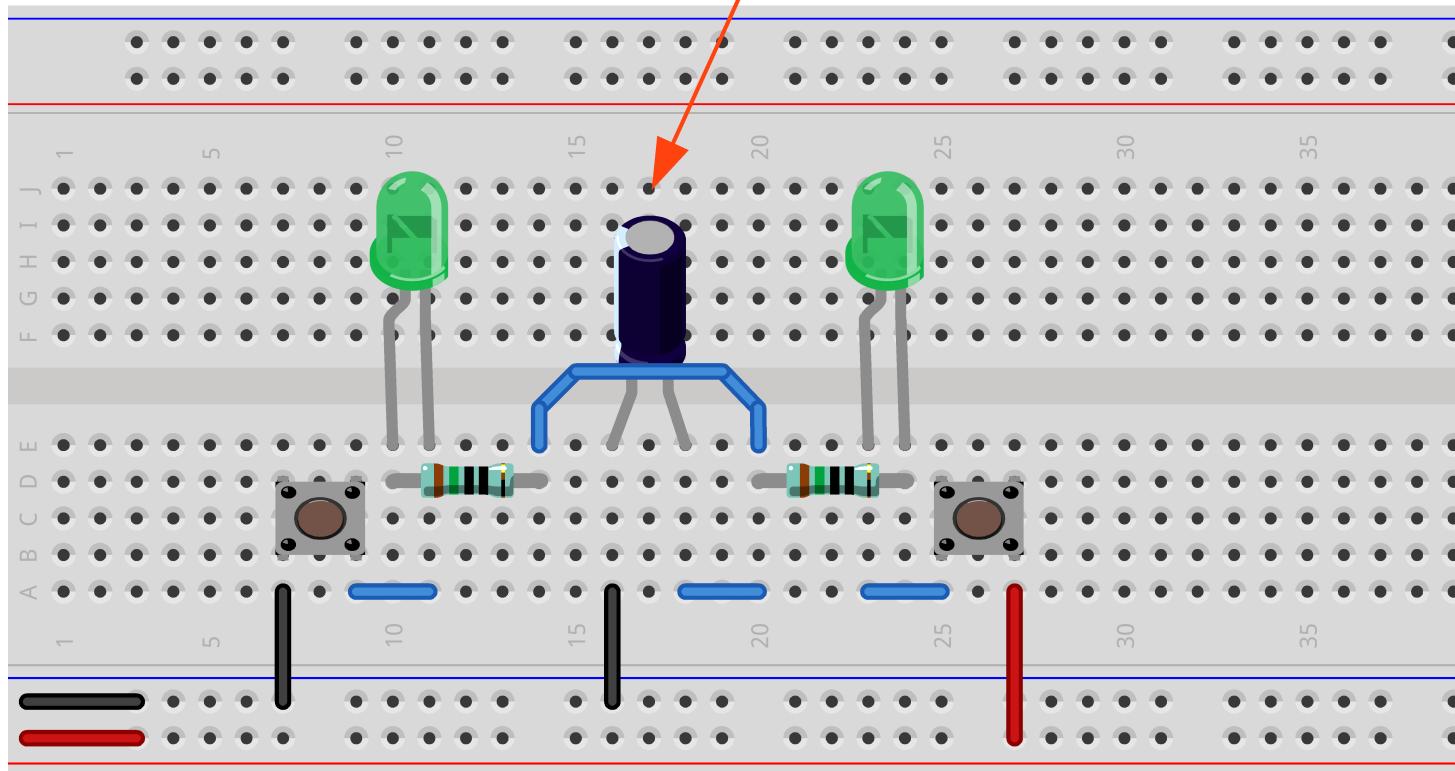
Press and hold  
to “charge” capacitor

# Different Capacitor Values

Breadboard

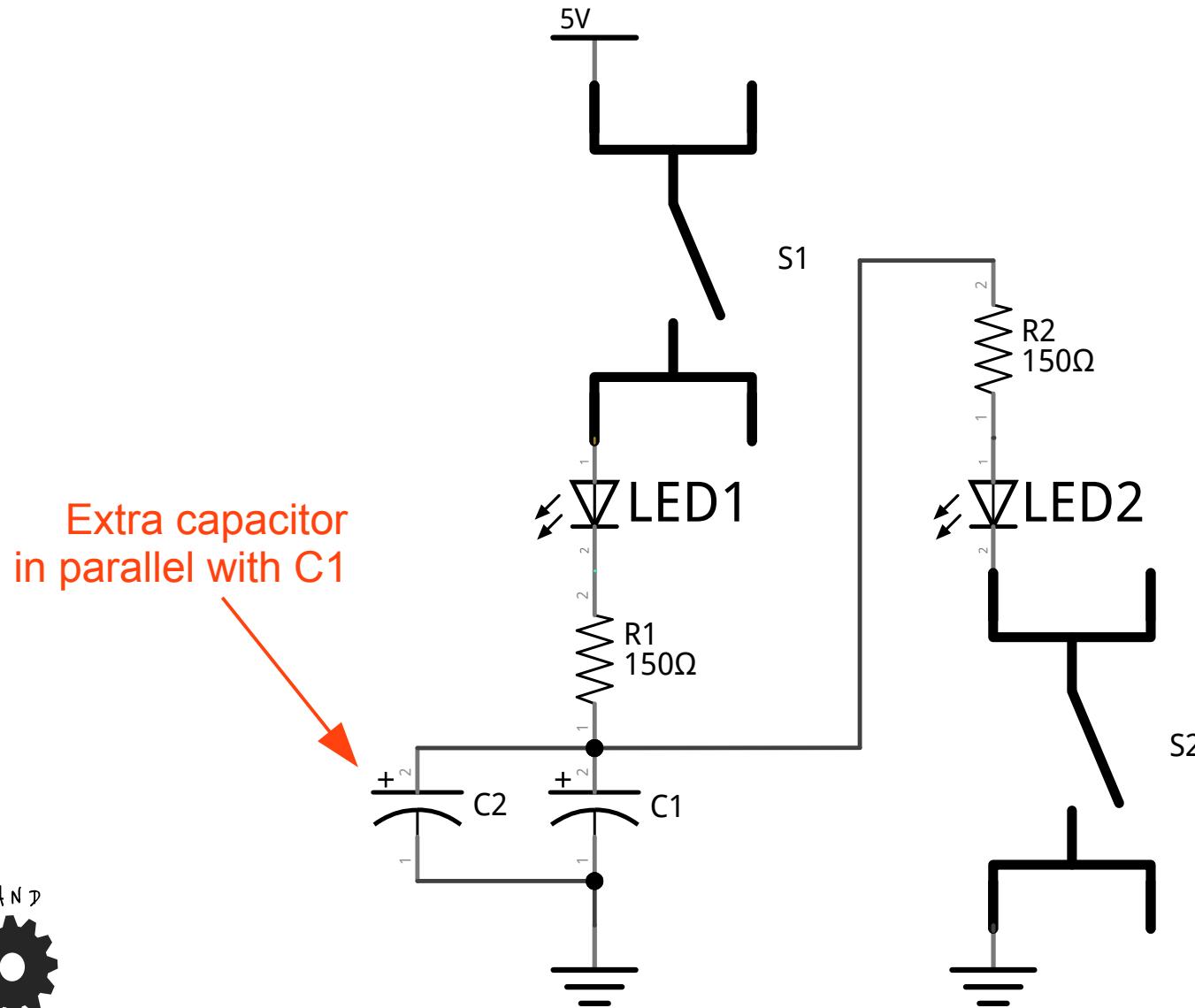
Replace with 1000 $\mu$ F capacitor  
Stripe on left side

Is the charge/discharge  
slower or faster?



# Capacitors In Parallel

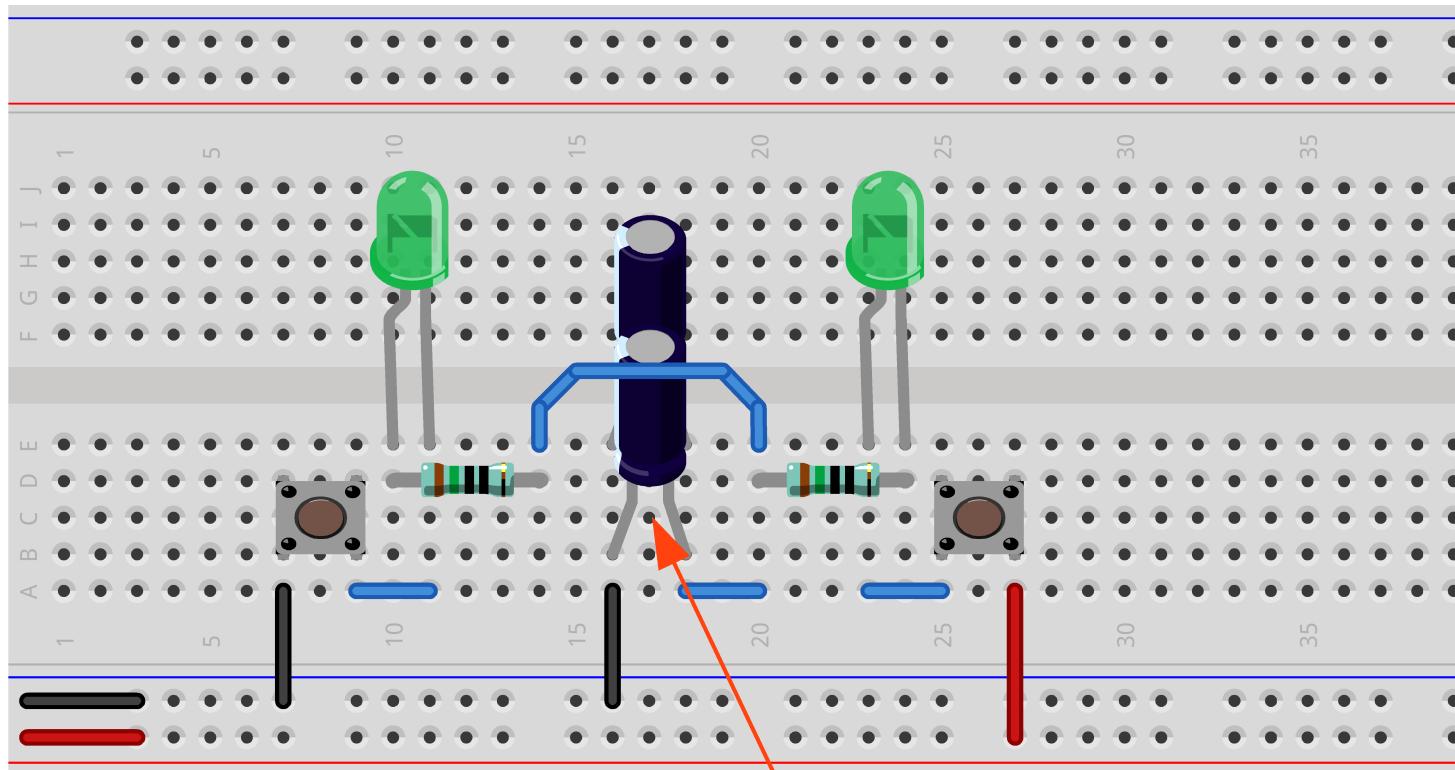
## Schematic



# Capacitors In Parallel

## Breadboard

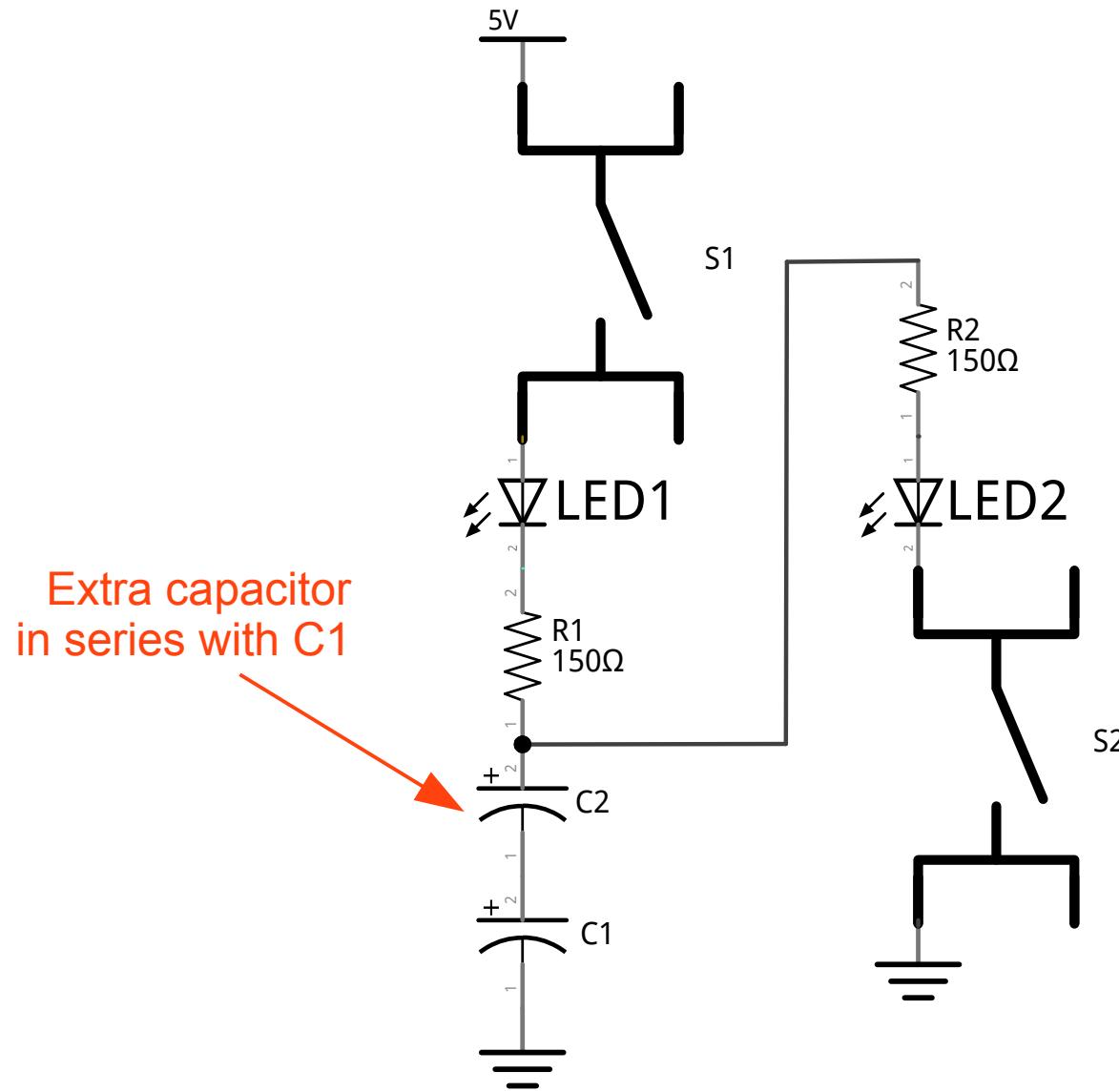
Is the charge/discharge  
slower or faster?



Add  $3300\mu\text{F}$  capacitor  
Straddle the same rows  
Stripe on left side

# Capacitors In Series

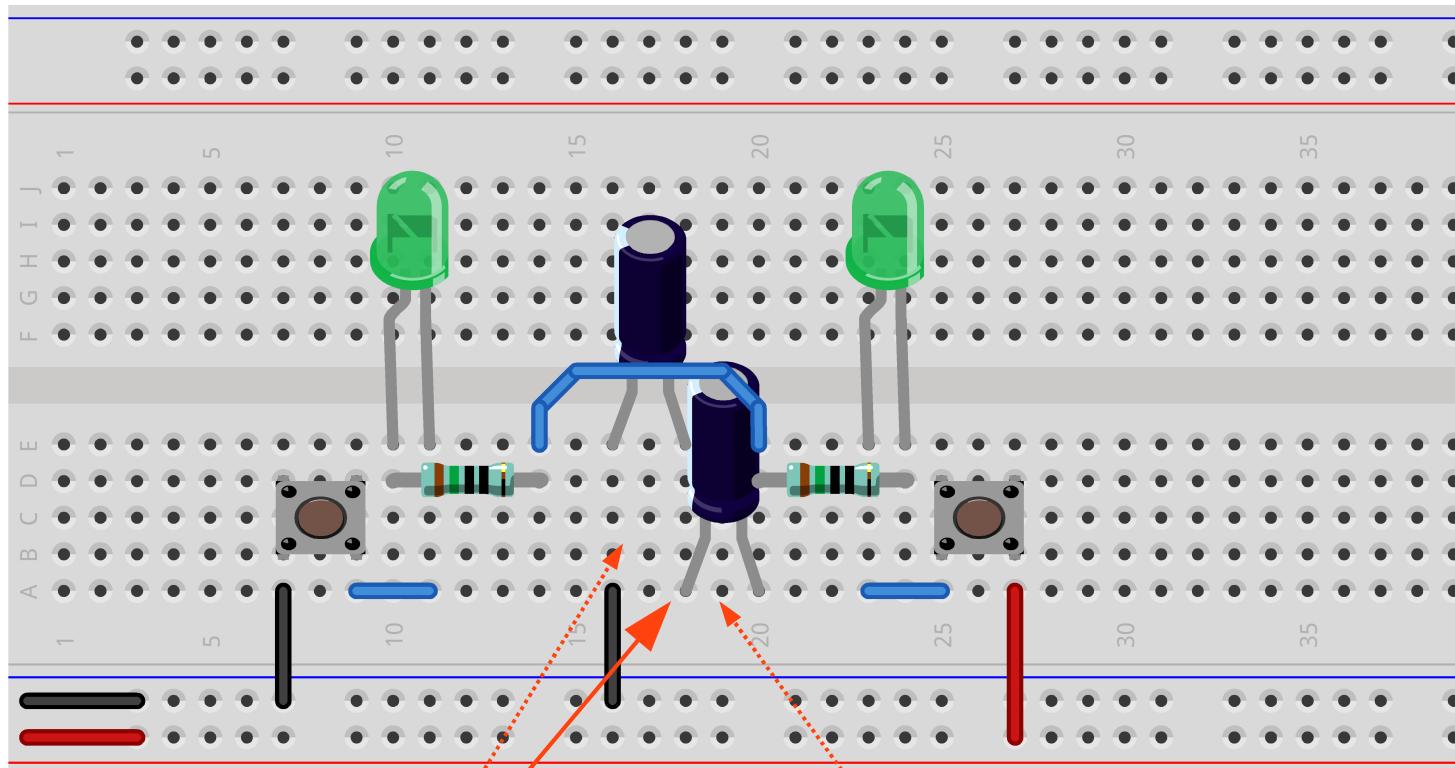
## Schematic



# Capacitors In Series

## Breadboard

Is the charge/discharge  
slower or faster?



Remove wire

Move 3300µF capacitor

# Questions

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- [http://en.wikipedia.org/wiki/File:Batteries\\_comparison\\_4,5\\_D\\_C\\_AA\\_AAA\\_AAAA\\_A23\\_9V\\_CR2032\\_LR44\\_matchstick-vertical.jpeg](http://en.wikipedia.org/wiki/File:Batteries_comparison_4,5_D_C_AA_AAA_AAAA_A23_9V_CR2032_LR44_matchstick-vertical.jpeg)  
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