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# EECS 16A Imaging 1

\*\*Insert your names here\*\*

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# Semester Outline



Imaging  
Module



Touchscreen  
Module



Acoustic  
Positioning  
Module

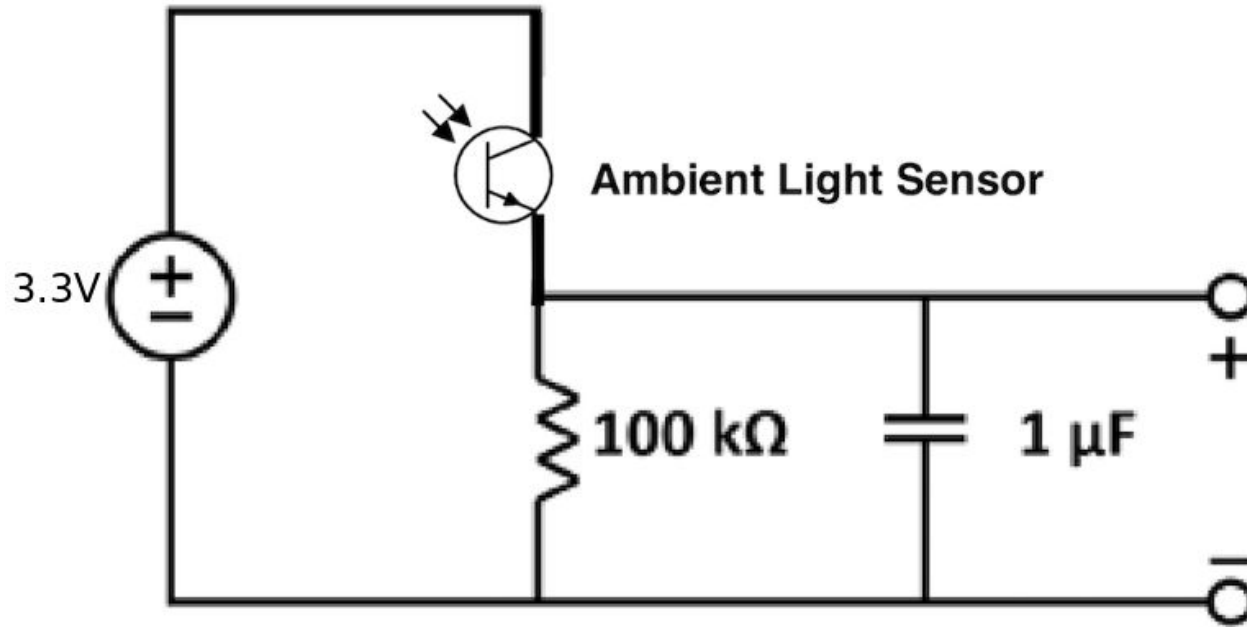
# Why Imaging?

- Use linear algebra techniques to capture real world images with limited sensors
- Today:
  - Finding a link between physical quantities and voltage
  - If you can digitize it, you can do anything (IOT devices, internet, code, processing)

# Today's Lab: Imaging Part 1

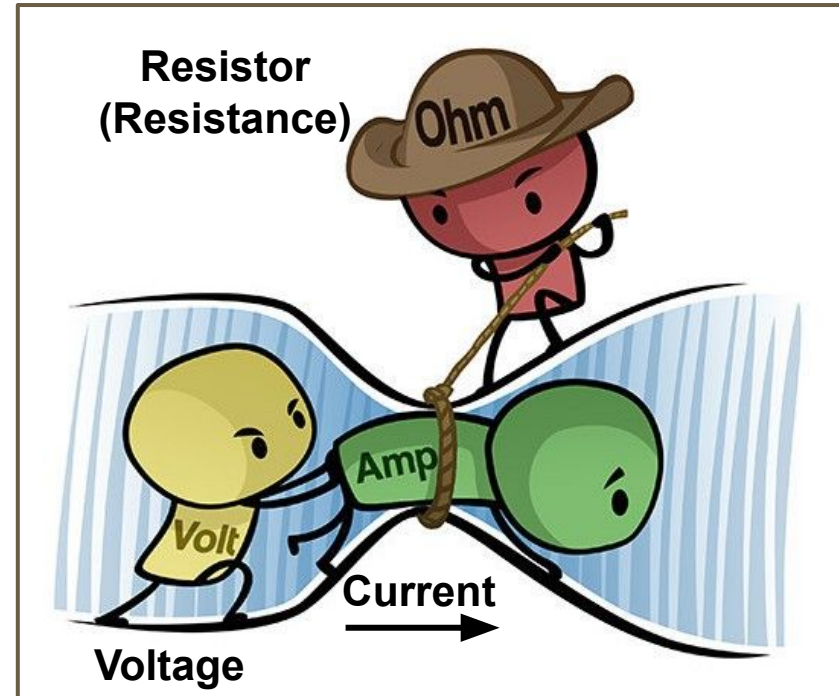
- You'll receive lab kit materials after completing part 1 of today's lab (TI MSP430F5529 + lab kit)
- Circuits + Breadboarding 101
- Build circuit that reacts to light intensity
  - Use Launchpad (+ Oscilloscope) to see how the circuit behaves
- Graded checkoff starts today!

## Our circuit



# A Little Physics: Voltage, Current, and Resistors

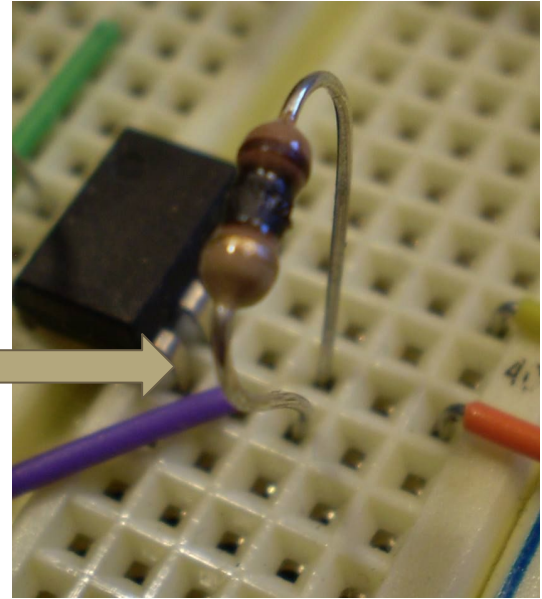
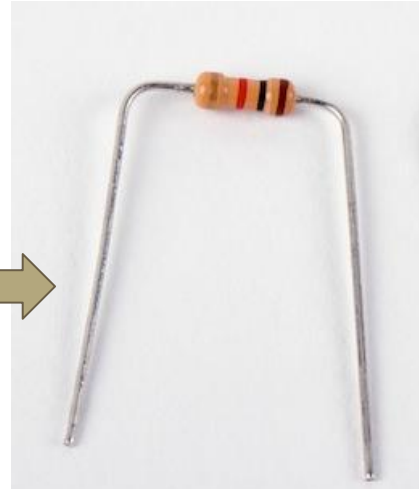
- **Voltage [Volts]** - pushes charge through circuit
- **Current [Amps]** - flow of charge through circuit
  - 1 Amp = 1 charge per second
- **Resistor [Ohms]** - circuit component that resists the flow of charge through circuit



# Simple Circuit: The Tools™

- Components
  - Resistors
  - Capacitors
  - Voltage Source
- Wires / Jumpers [pin-to-pin vs pin-to-socket]

# What's in your circuit? : Resistors





# What's on your circuit? : Resistors



**4 Band Resistor Color Coding**

COLOR	1ST BAND	2ND BAND	MULTIPLIER	TOLERANCE
BLACK	0	0	x1 $\Omega$	
BROWN	1	1	x10 $\Omega$	$\pm 1\%$
RED	2	2	x100 $\Omega$	$\pm 2\%$
ORANGE	3	3	x1000 $\Omega$	
YELLOW	4	4	x10000 $\Omega$	
GREEN	5	5	x100000 $\Omega$	$\pm 0.5\%$
BLUE	6	6	x1000000 $\Omega$	$\pm 0.25$
VIOLET	7	7	x10000000 $\Omega$	$\pm 0.10$
GREY	8	8		$\pm 0.05$
WHITE	9	9		
GOLD			0.1	$\pm 5\%$
SILVER			0.01	$\pm 10\%$

# What's on your circuit? : Resistors



4 Band Resistor Color Coding



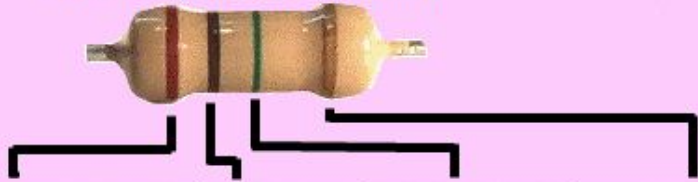
COLOR	1ST BAND	2ND BAND	MULTIPLIER	TOLERANCE
BLACK	0	0	x1 $\Omega$	
BROWN	1	1	x10 $\Omega$	$\pm 1\%$
RED	2	2	x100 $\Omega$	$\pm 2\%$
ORANGE	3	3	x1000 $\Omega$	
YELLOW	4	4	x10000 $\Omega$	
GREEN	5	5	x100000 $\Omega$	$\pm 0.5\%$
BLUE	6	6	x1000000 $\Omega$	$\pm 0.25\%$
VIOLET	7	7	x10000000 $\Omega$	$\pm 0.1\%$
GREY	8	8		$\pm 0.05\%$
WHITE	9	9		
GOLD			0.1	$\pm 5\%$
SILVER			0.01	$\pm 10\%$

Difficult to see on projector:  
this says "x1 $\Omega$ ", not "x10"

# Poll Time! What color is a 100 ohm resistor?



**4 Band Resistor Color Coding**



COLOR	1ST BAND	2ND BAND	MULTIPLIER	TOLERANCE
BLACK	0	0	x1 $\Omega$	
BROWN	1	1	x10 $\Omega$	$\pm 1\%$
RED	2	2	x100 $\Omega$	$\pm 2\%$
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GREY	8	8		$\pm 0.05\%$
WHITE	9	9		
GOLD			0.1	$\pm 5\%$
SILVER			0.01	$\pm 10\%$

1. black-brown-red
2. brown-black-brown
3. brown-black-red
4. brown-black-black

# Poll Time! What color is a 100 ohm resistor?



**4 Band Resistor Color Coding**

COLOR	1ST BAND	2ND BAND	MULTIPLIER	TOLERANCE
BLACK	0	0	x1 $\Omega$	
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GREY	8	8		$\pm 0.05\%$
WHITE	9	9		
GOLD			0.1	$\pm 5\%$
SILVER			0.01	$\pm 10\%$

1. black-brown-red
2. **brown-black-brown**
3. brown-black-red
4. brown-black-black

# Poll Time! What color is a 100K resistor? (100 kilo-ohms, so 100,000 ohms)



**4 Band Resistor Color Coding**

COLOR	1ST BAND	2ND BAND	MULTIPLIER	TOLERANCE
BLACK	0	0	$\times 1\Omega$	
BROWN	1	1	$\times 10\Omega$	$\pm 1\%$
RED	2	2	$\times 100\Omega$	$\pm 2\%$
ORANGE	3	3	$\times 1000\Omega$	
YELLOW	4	4	$\times 10000\Omega$	
GREEN	5	5	$\times 100000\Omega$	$\pm 0.5\%$
BLUE	6	6	$\times 1000000\Omega$	$\pm 0.25\%$
VIOLET	7	7	$\times 10000000\Omega$	$\pm 0.10\%$
GREY	8	8		$\pm 0.05\%$
WHITE	9	9		
GOLD			0.1	$\pm 5\%$
SILVER			0.01	$\pm 10\%$

1. brown-black-red
2. brown-black-brown
3. brown-black-yellow
4. brown-black-white

# Poll Time! What color is a 100K resistor? (100 kilo-ohms, so 100,000 ohms)



**4 Band Resistor Color Coding**

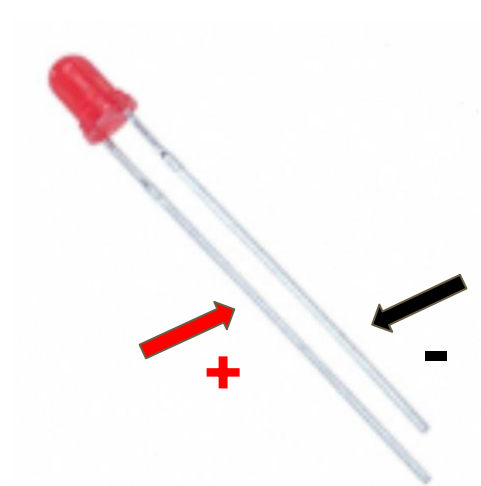
COLOR	1ST BAND	2ND BAND	MULTIPLIER	TOLERANCE
BLACK	0	0	x1 $\Omega$	
BROWN	1	1	x10 $\Omega$	$\pm 1\%$
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BLUE	6	6	x1000000 $\Omega$	$\pm 0.25\%$
VIOLET	7	7	x10000000 $\Omega$	$\pm 0.10\%$
GREY	8	8		$\pm 0.05\%$
WHITE	9	9		
GOLD			0.1	$\pm 5\%$
SILVER			0.01	$\pm 10\%$

1. brown-black-red
2. brown-black-brown
- 3. brown-black-yellow**
4. brown-black-white

# Light Emitting Diode (LED)

When a sufficient potential difference is placed across its terminals, the LED emits light!

Direction matters!

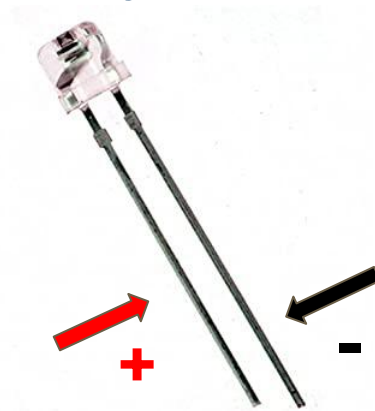


# Ambient Light Sensor



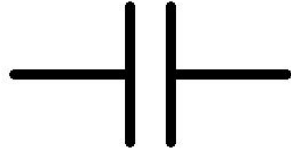
It behaves like a resistor and the current passing through it depends on how much light there is around it!

Direction matters! **Note: Polarity is opposite LED's**





# Capacitors

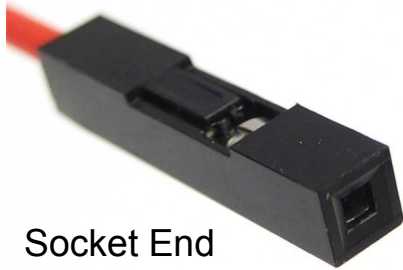


They store your charge!  
Called capacitors because  
they have a set capacity (in  
Farads)

# Wires/Jumpers



Pin End

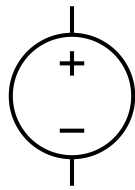


Socket End

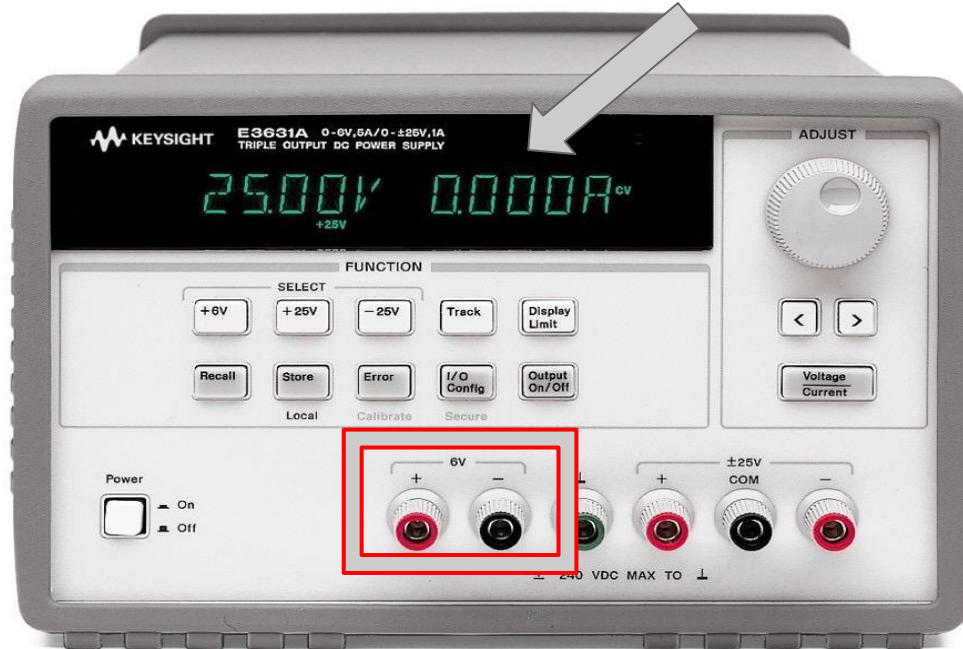


**IMPORTANT:** we use pin/socket terminology for wiring. You may encounter male/female in documentation or in industry.

# Voltage Source

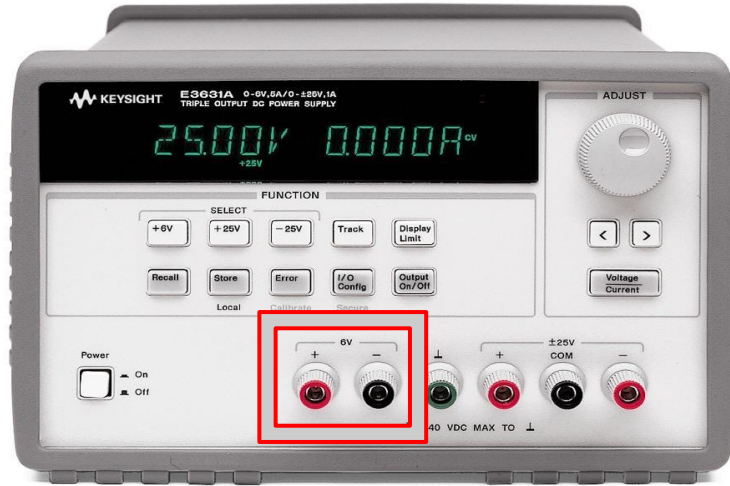
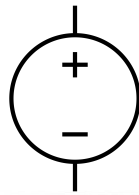


**IMPORTANT: Always keep current limited @ 0.1 A limit**



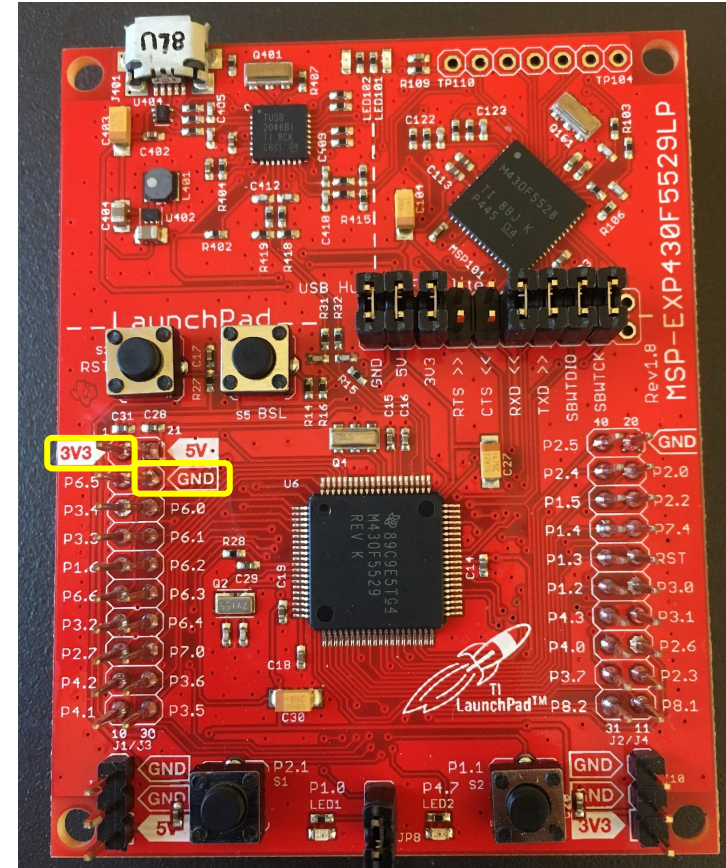
PSU cables are hanging on back wall

# Voltage Source



Power Supply Unit (PSU)

**We will be using the LaunchPad as well as the PSU as our voltage source. The 3V3 and GND pins on the LaunchPad are the + and - terminals of the voltage source respectively**



# Simple Circuit: The Theory

- Components
- Nodes
  - Point in circuit where circuit elements meet
  - Wire between components are considered part of one node
- We know you don't know much about circuits yet; we've given you very detailed instructions on how to build the circuit in the lab

# Simple Circuit: The Theory™

- Components (Resistors, LEDs, Capacitors)
- Nodes
  - Point in circuit where circuit elements meet
  - Wire between components are considered part of one node



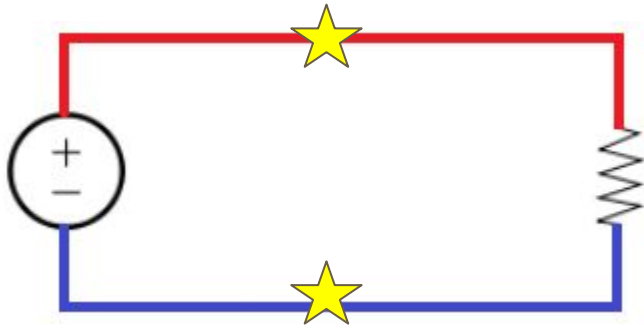
What components?

How many nodes?

Where are these nodes?

# Simple Circuit: The Theory™

- Components (Resistors, LEDs, Capacitors)
- Nodes
  - Point in circuit where circuit elements meet
  - Wire between components are considered part of one node



What components?

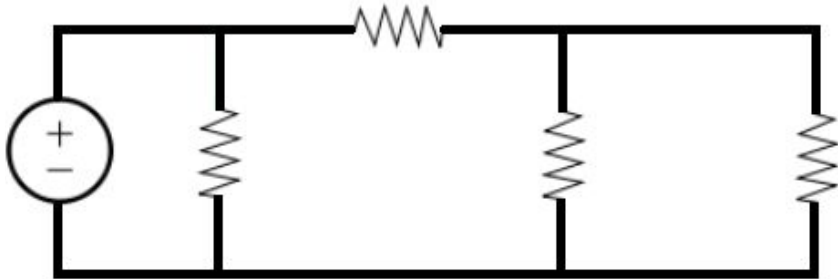
**Voltage source, resistor**

How many nodes? **2**

Where are these nodes?

# Simple Circuit: The Theory™

- Components (Resistors, LEDs, Capacitors)
- Nodes
  - Point in circuit where circuit elements meet
  - Wire between components are considered part of one node



What components?

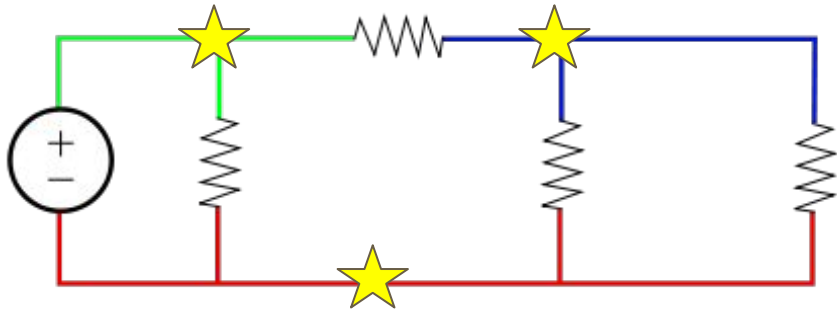
How many nodes?

Where are these nodes?



# Simple Circuit: The Theory™

- Components (Resistors, LEDs, Capacitors)
- Nodes
  - Point in circuit where circuit elements meet
  - Wire between components are considered part of one node

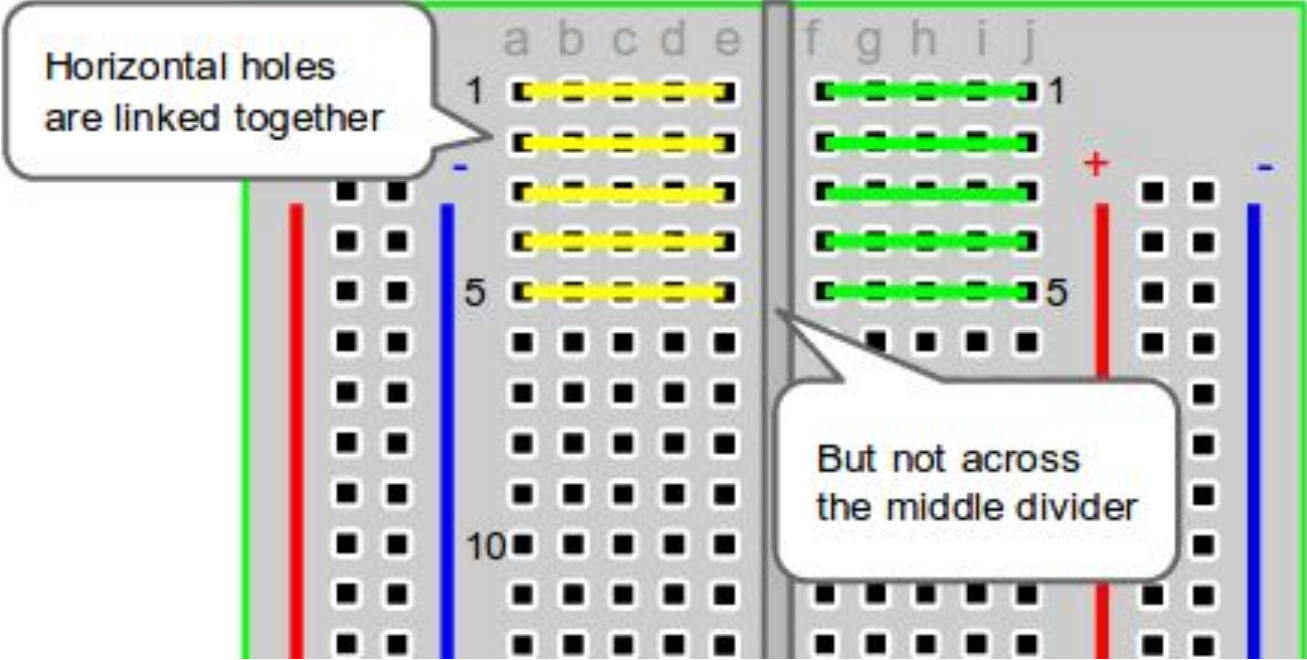


What components? **Same**

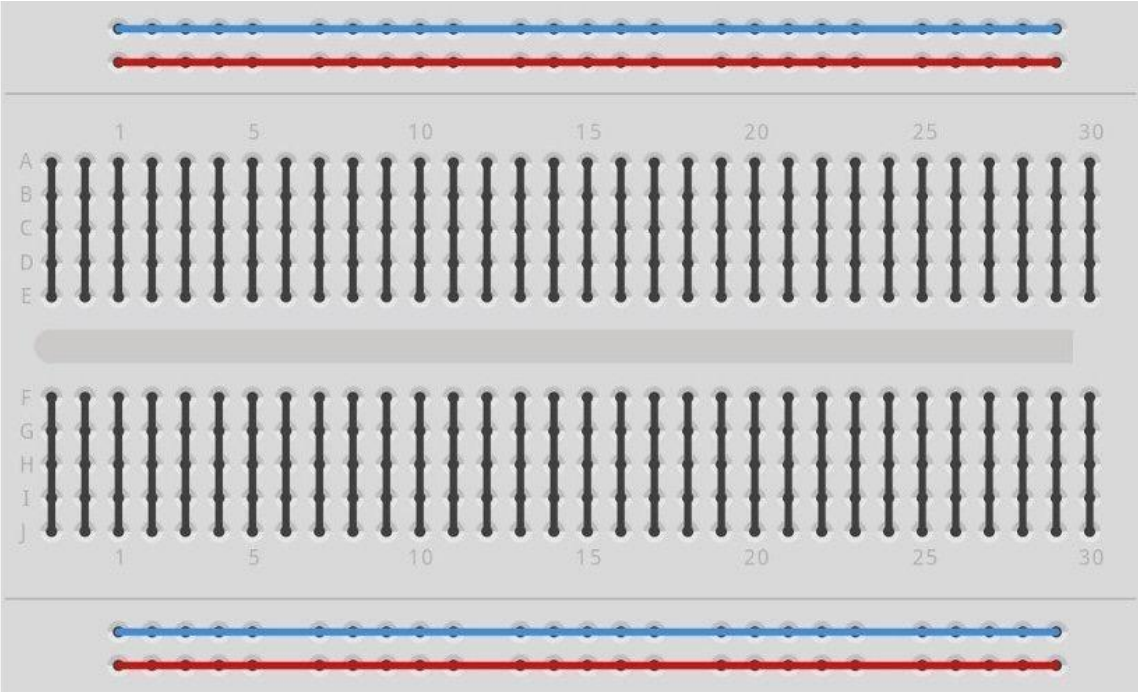
How many nodes? **3**

Where are these nodes?

# Breadboard



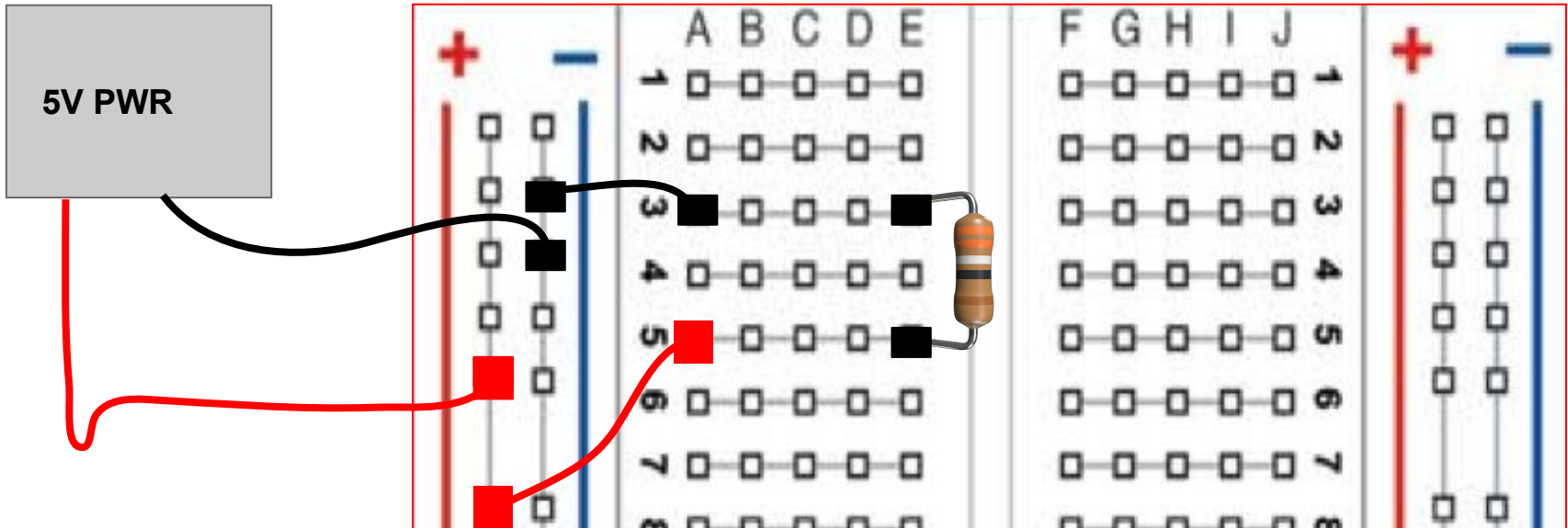
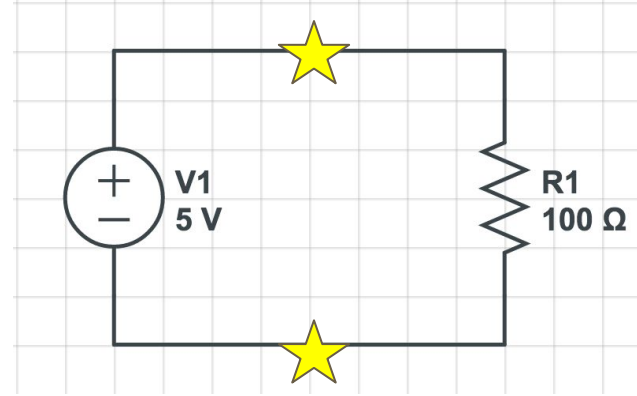
# Breadboard





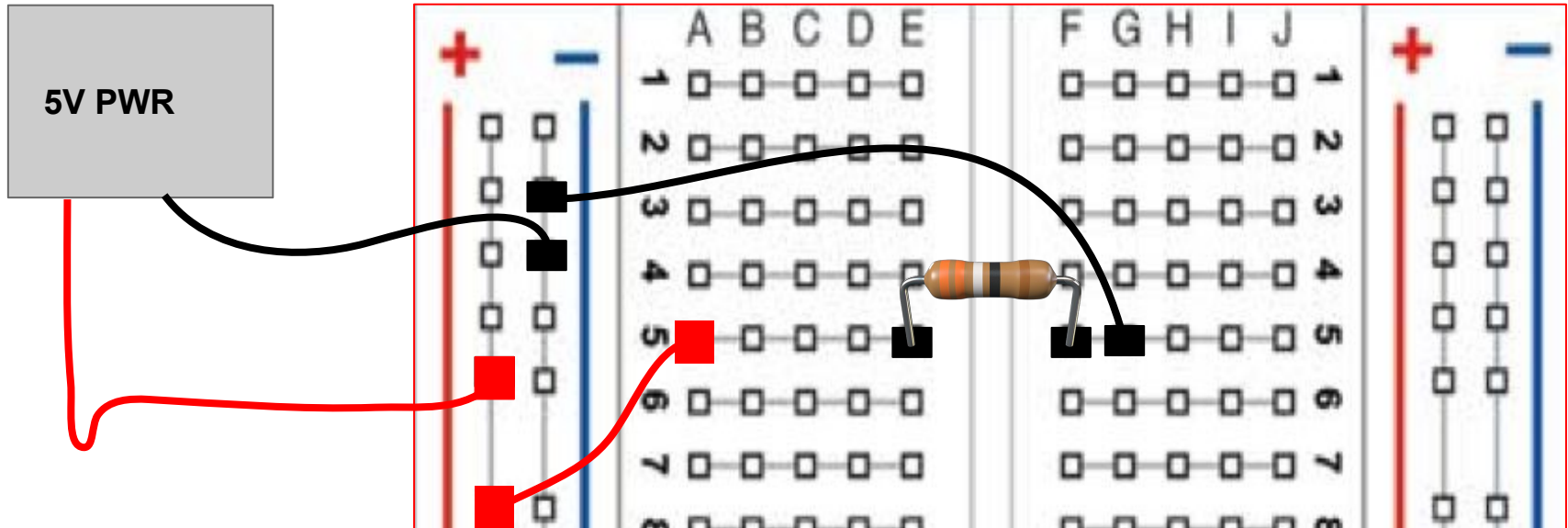
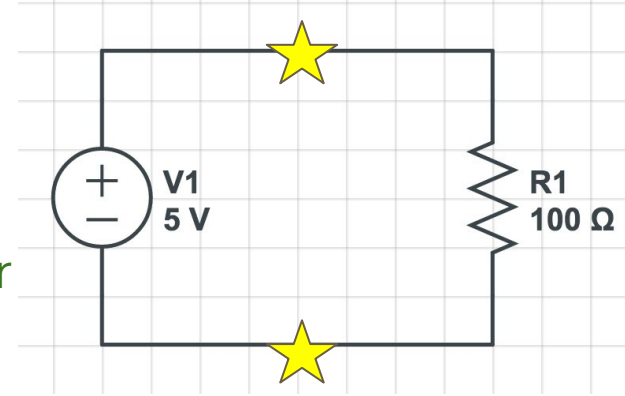
# Breadboard Do's and Don't's

- ✓ **Do** plug component's ends into two different rows - separate nodes



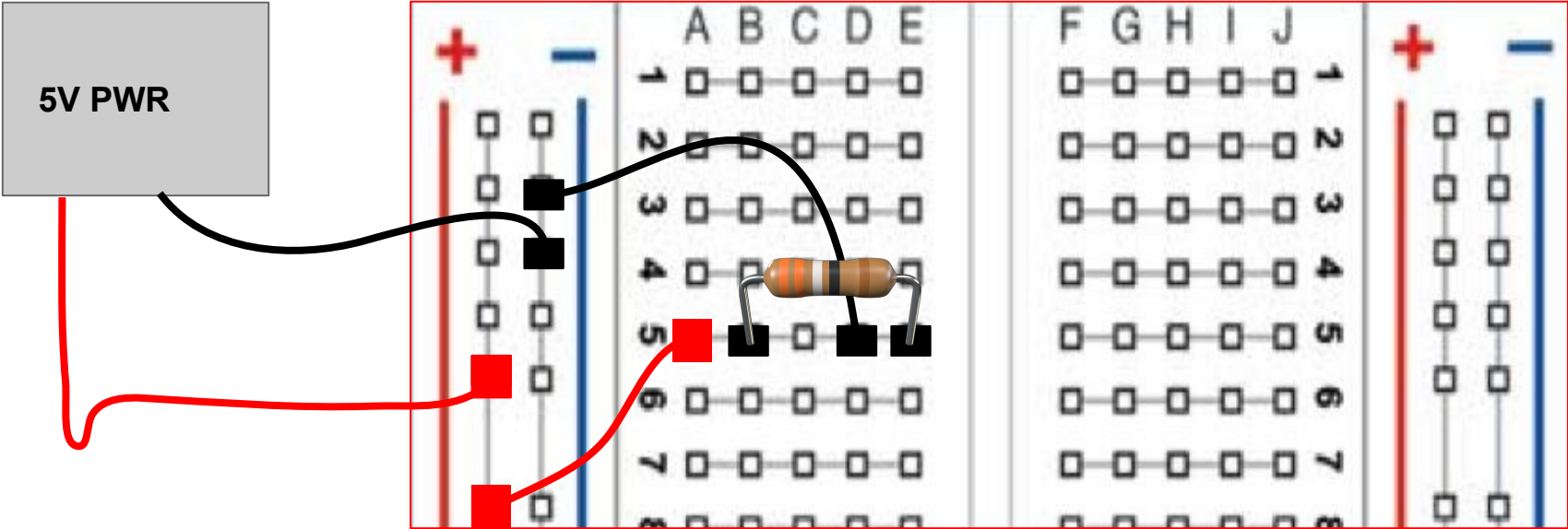
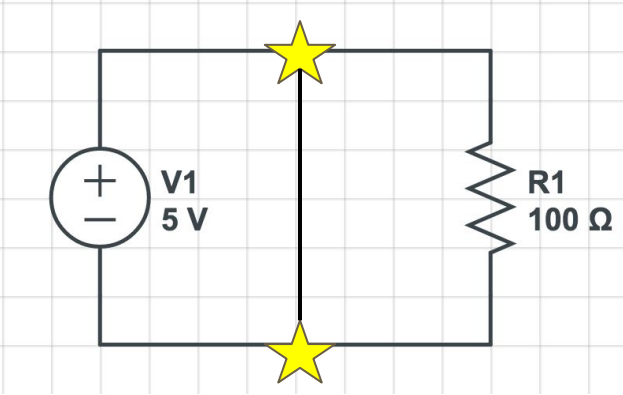
# Breadboard Do's and Don't's

- ✓ **Do** plug components across the gap in your breadboard - A-E and F-J are separate



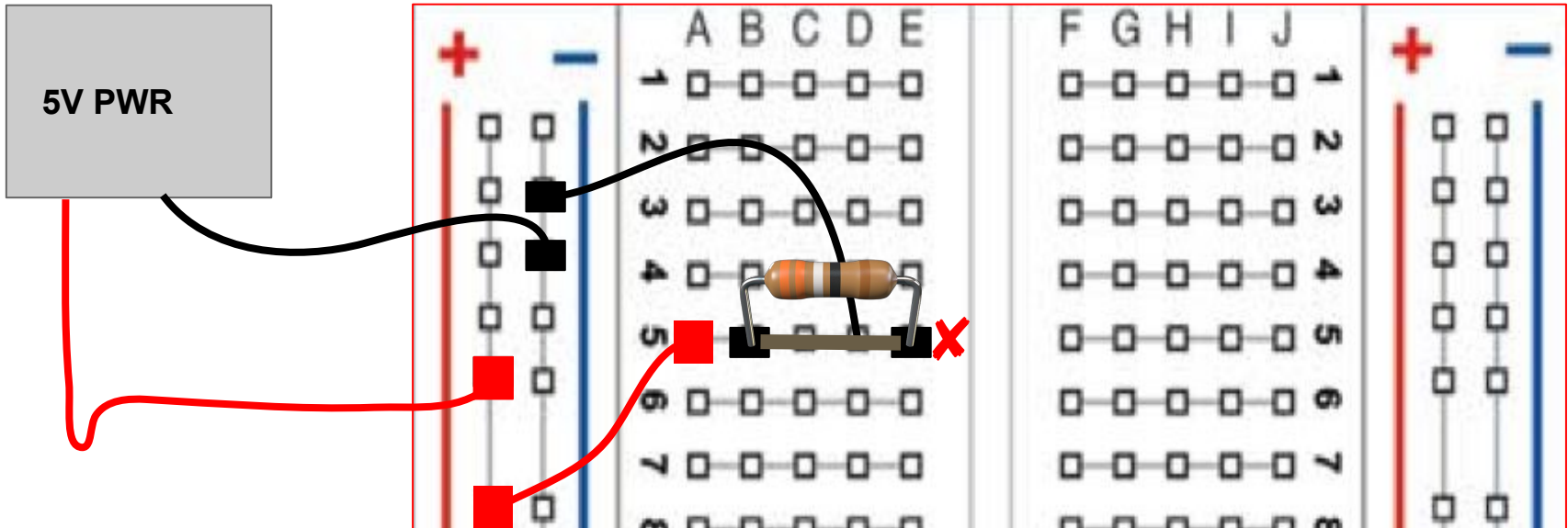
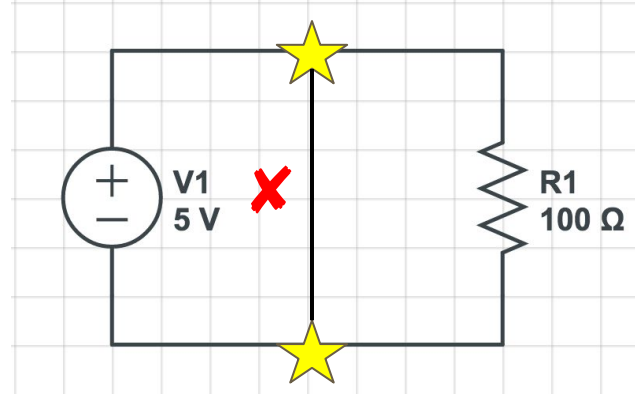
# Breadboard Do's and Don't's

Is this okay? If there is an error, where?



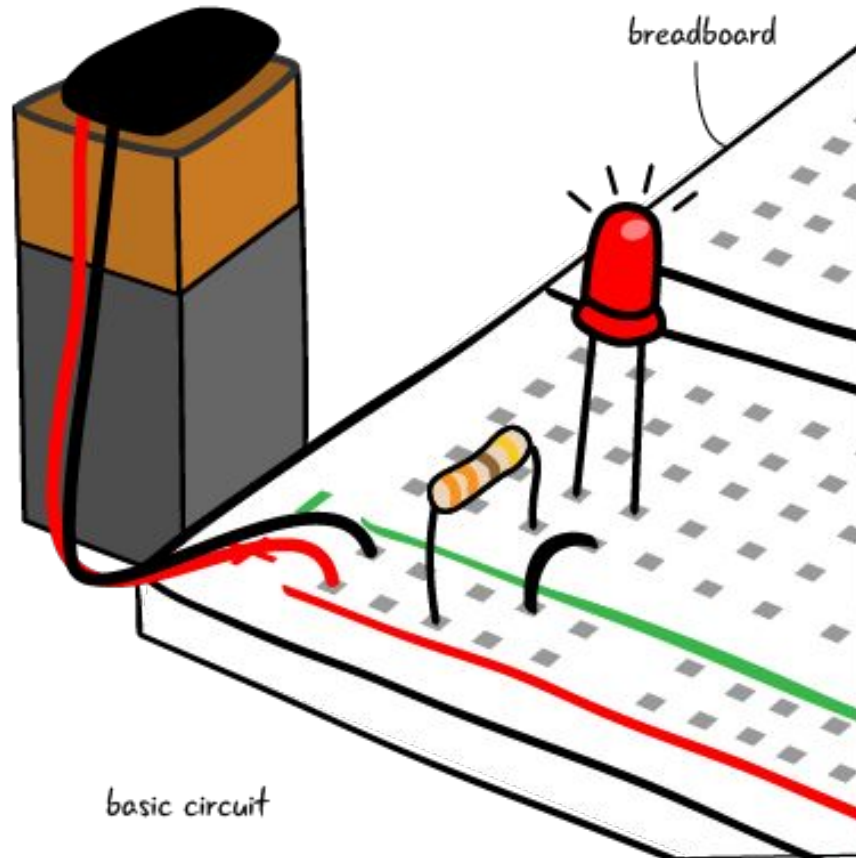
# Breadboard Do's and Don't's

✗ **Do not** plug both ends of component into the same row! This creates a short

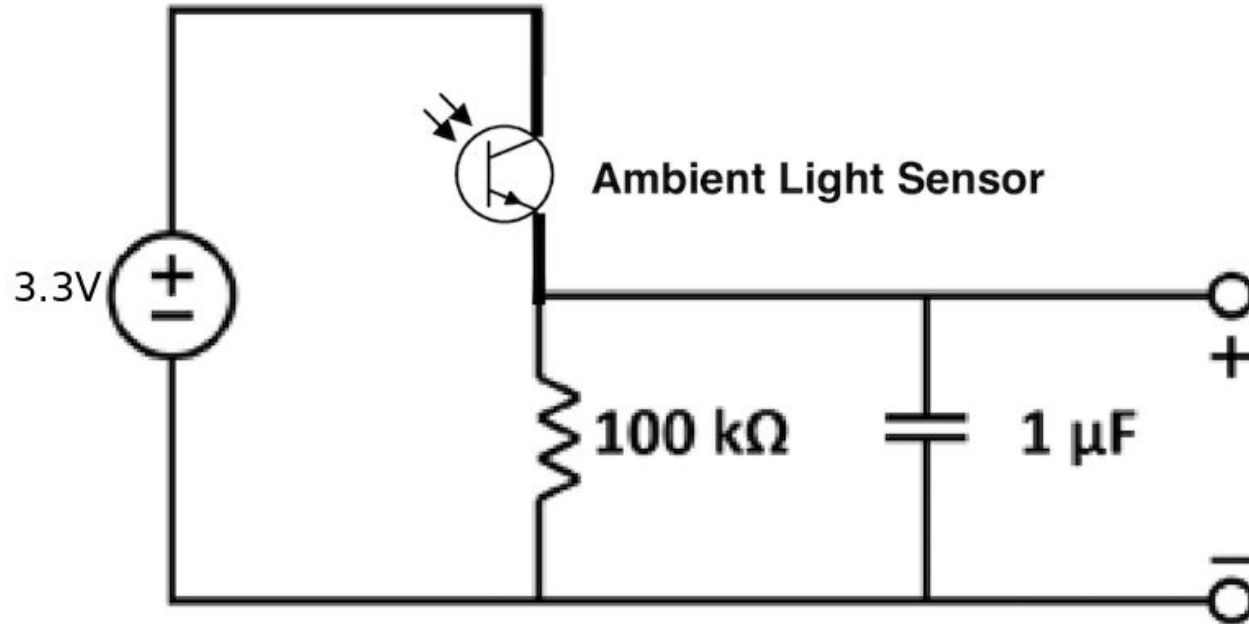




# Breadboarding Color Convention

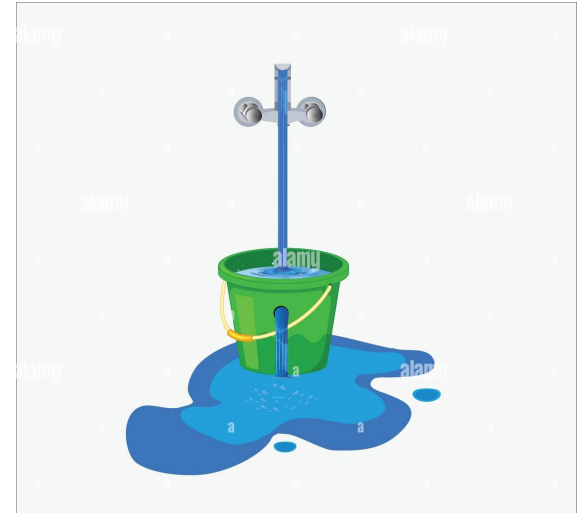
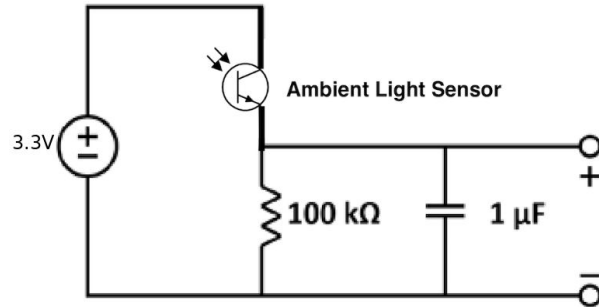
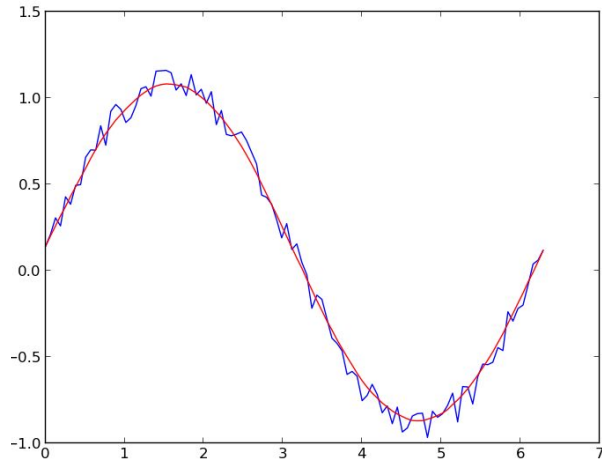


# Light-detecting Circuit



# Why the Capacitor?

- The capacitor acts like a bucket of charge – if the input instantaneously increases or decreases, it'll adjust the output flow to compensate
- This results in reducing noise and curve smoothing!



# FAQ

- Complete the lab in **PAIRS**, do ONE setup and notebook per group
- Speak to the staff if you do not have a partner and would like one
- **DON'T LEAVE/PACK UP YOUR CIRCUIT WITHOUT BEING CHECKED OFF FIRST**

# FAQ

- Make sure current limit of power supply is set to 0.1A
- Turn PSU **output off** while building your circuit
- Keep voltage source leads from LaunchPad to breadboard disconnected while building your circuit
  - Socket ends can stay connected to the LaunchPad
- Probes are on the back wall
- **Make sure you are using the correct resistors (Brown Black Yellow Gold for light sensor)**
- **Make sure your ambient light sensor is in the right direction**
- Before leaving, please return the wires, power off your machines, and sign out of the computers
- If images in the notebook don't show up, save your work and reopen the notebook