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# EECS 16A Imaging 1

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

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# IMPORTANT: LAB CAPACITY

- Only students enrolled in this lab section should be present here
- If you **lie** about being enrolled in this section, you will be **REMOVED** from the course
  - Please be ready to show either CalCentral enrollment or an email confirming a switch.

# IMPORTANT: COVID Protocols

- Masks are always required
- We will be checking green badges as students enter the lab
- Masks + Wipes + Sanitizers should be available at the TA desk
- Students will be required to wipe down their station before the start of every section
- Food and Drink are never allowed in the lab. This is especially true this semester. Students and staff should go outside (either Cory courtyard or out of the building) for food or water.
- Please DO NOT COME TO LAB if you're UNWELL!

# Action Item: Instructional Accounts

- To use the computers at the lab stations, you will need to login using your instructional account
- Create an EE16A account by logging into [acropolis](#) with your CalNet ID.
- Click “Create an Account” for EE16A and wait for the page to create an account.
- You will be presented with an ee16a account and a password and prompted with an option to send the account information to an email. Please email this account information to yourself.

# Action Item: Instructional Accounts

- On a Windows computer, you can change your password by hitting Control + Alt + Delete and selecting “Change Password”. Follow the prompt to permanently change your password.
- If you ever forget the password that you set, you can reset it by going to acropolis and resetting the password associated with that account.

# 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 should have received lab materials (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!



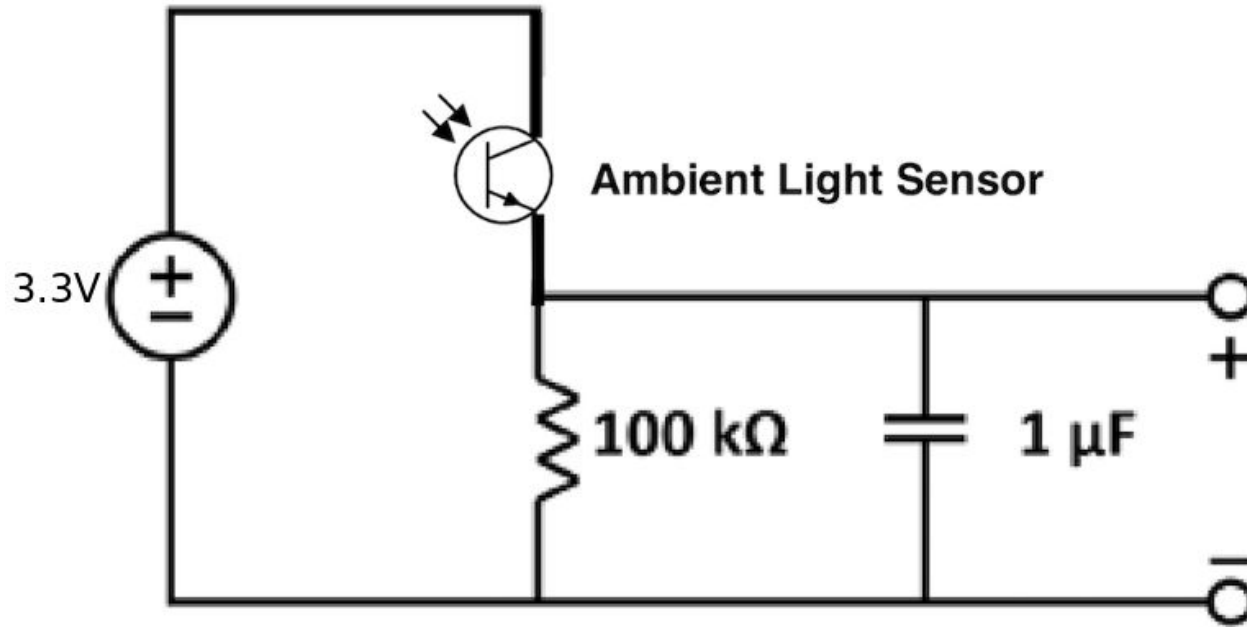
# Today's Lab: Imaging Part 1

- In-Person lab
  - Uses PSU, Oscilloscope and Launchpad
  
- Remote lab
  - Uses Virtual Oscilloscope and Launchpad

## Note for Remote Students

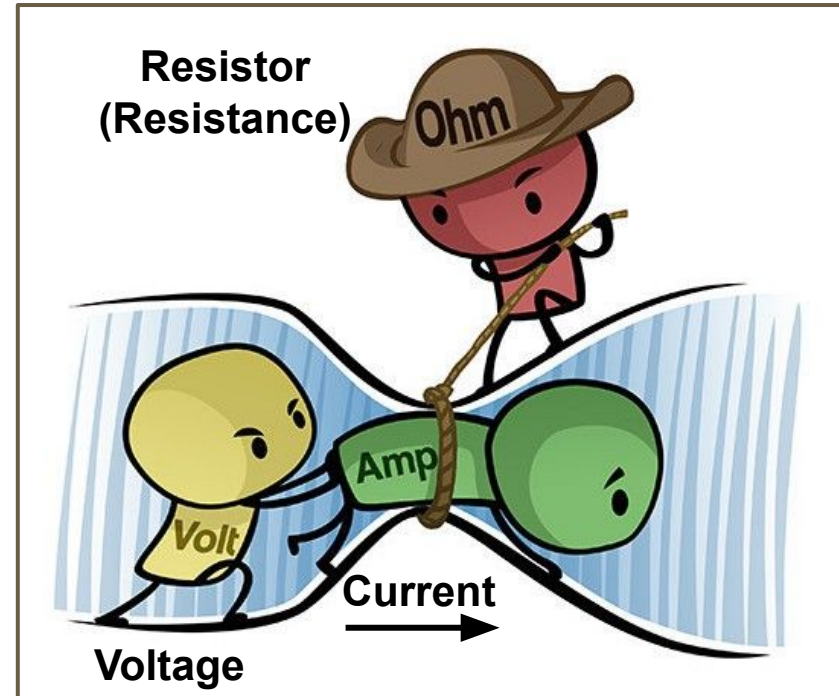
- Do not worry if you don't get the Launchpad/Energia setup working today
  - Attend buffer section to get help with Energia issues
  - Can still get checked off for Imaging 1 today

## Our circuit



# A Little Physics: Voltage, Current, and Resistors

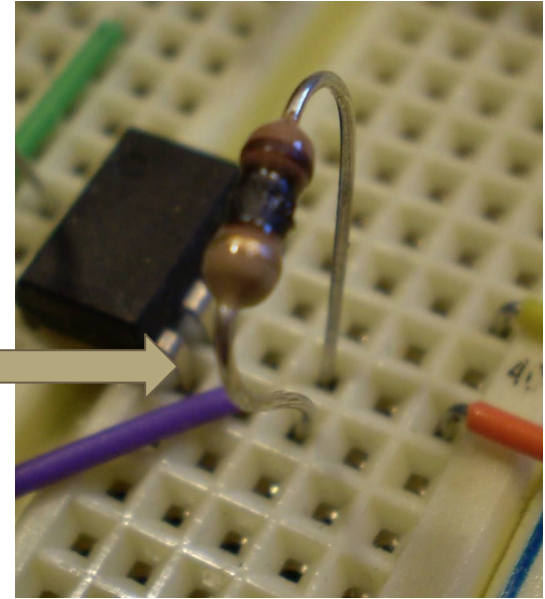
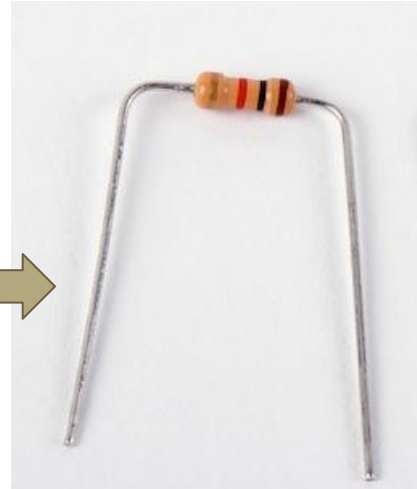
- **Voltage [Volts]** - pushes charge through circuit
- **Current [Amps]** - flow of charge through circuit
  - 1 Amp = 1 charge per second
- **Resistor [Ohms]** - circuit component that resists the flow of charge through circuit



# Simple Circuit: The Tools™

- Components
  - Resistors
  - Capacitors
  - Voltage Source
- Wires / Jumpers [male-to-male vs male-to-female]

# 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	$\pm 10\%$

# 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 $\Omega$	$\pm 2\%$
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	$\pm 10\%$

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**



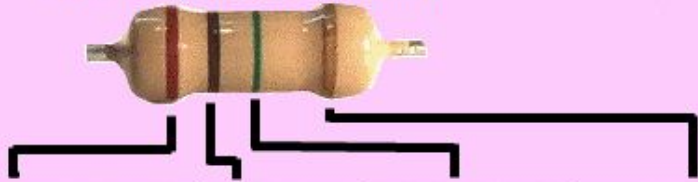
COLOR	1ST BAND	2ND BAND	MULTIPLIER	TOLERANCE
BLACK	0	0	x1 $\Omega$	
BROWN	1	1	x10 $\Omega$	$\pm 1\%$
RED	2	2	x100 $\Omega$	$\pm 2\%$
ORANGE	3	3	x1000 $\Omega$	
YELLOW	4	4	x10000 $\Omega$	
GREEN	5	5	x100000 $\Omega$	$\pm 0.5\%$
BLUE	6	6	x1000000 $\Omega$	$\pm 0.25\%$
VIOLET	7	7	x10000000 $\Omega$	$\pm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

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	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	$\pm 10\%$

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	x1Ω	
BROWN	1	1	x10Ω	±1%
RED	2	2	x100Ω	±2%
ORANGE	3	3	x1000Ω	
YELLOW	4	4	x10000Ω	
GREEN	5	5	x100000Ω	±0.5%
BLUE	6	6	x1000000Ω	±0.25%
VIOLET	7	7	x10000000Ω	±0.1%
GREY	8	8		±0.05%
WHITE	9	9		
GOLD			0.1	±5%
SILVER			0.01	±10%

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

# Ambient Light Sensor

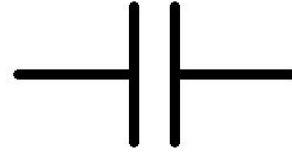


It behaves like a resistor and the current passing through it depends on how much light there is around it!

Direction matters!



# Equipment for Today: Capacitors



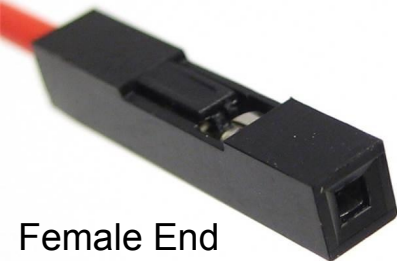
They store your charge!  
Called capacitors because  
they have a set capacity (in  
Farads)

# Equipment for Today: Wires/Jumpers

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Male End

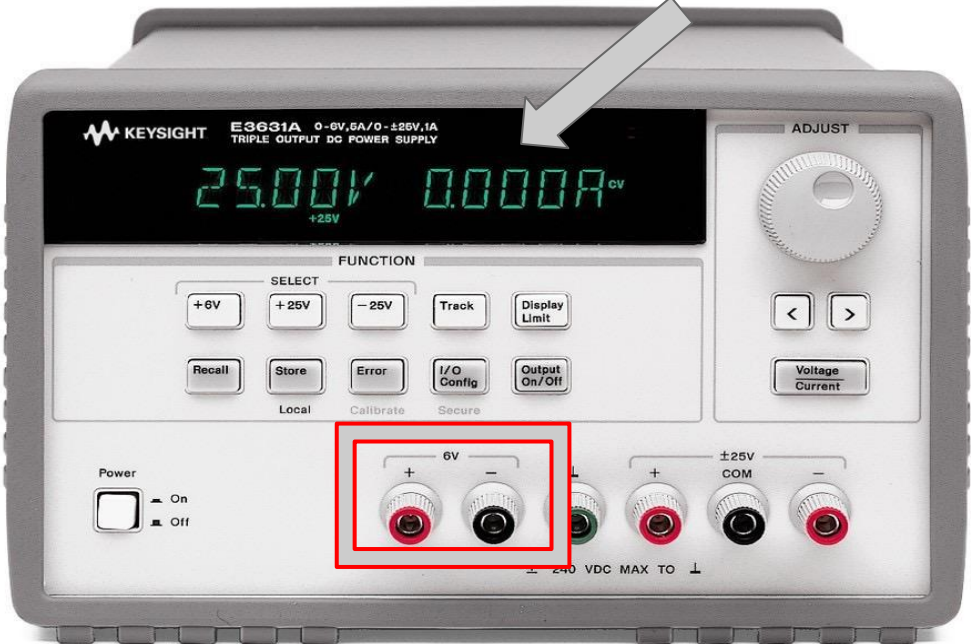
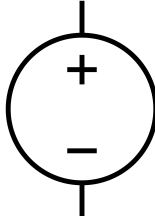


Female End



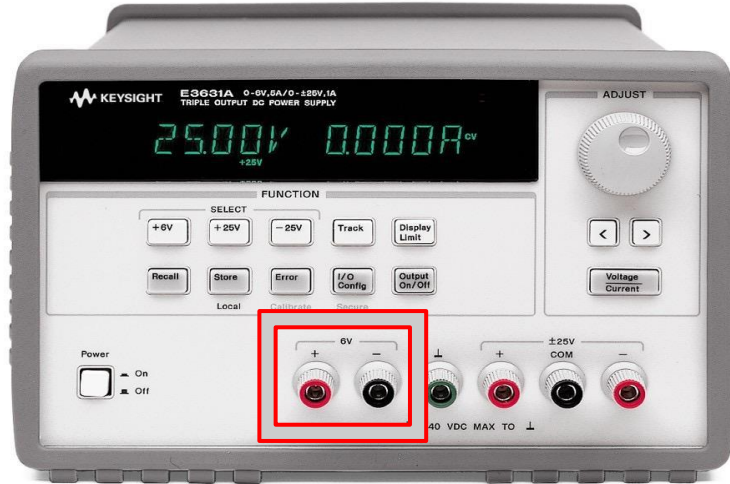
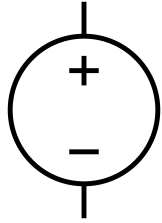
# Equipment for Today: Voltage Source

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



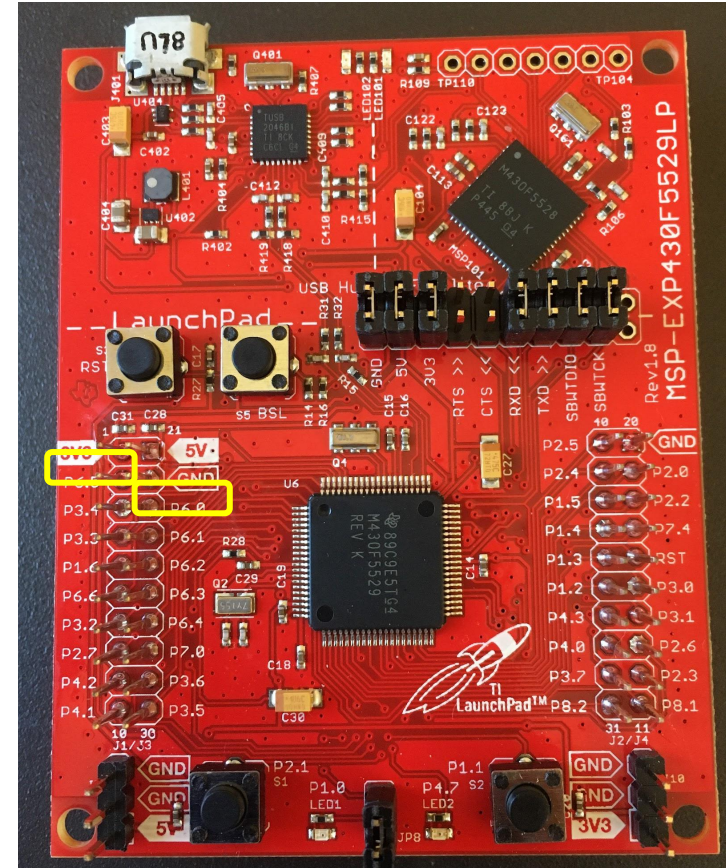
PSU cables are hanging on back wall

# Equipment for Today: Voltage Source



Power Supply Unit (PSU)

**We will be using the LaunchPad instead of 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



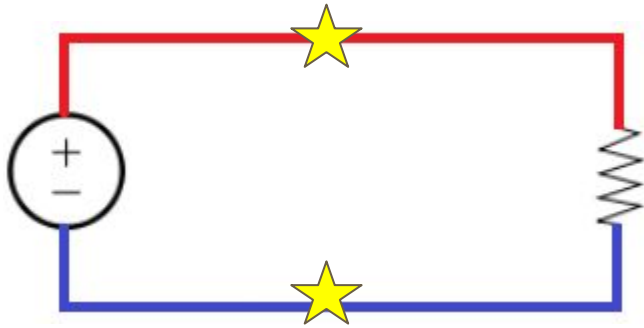
What components?

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?

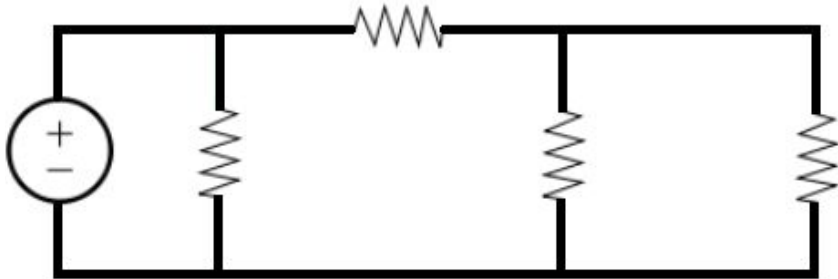
**Voltage source, resistor**

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



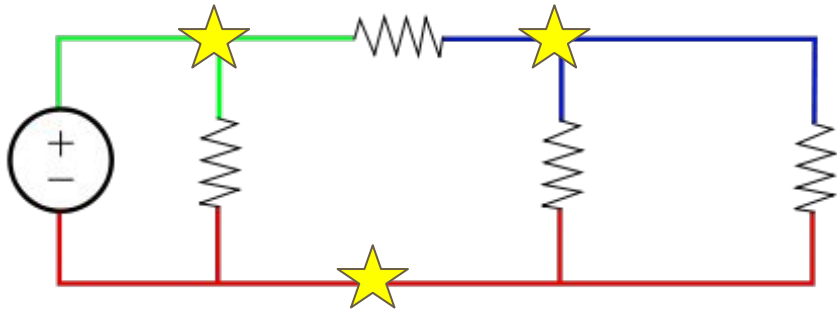
What components?

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

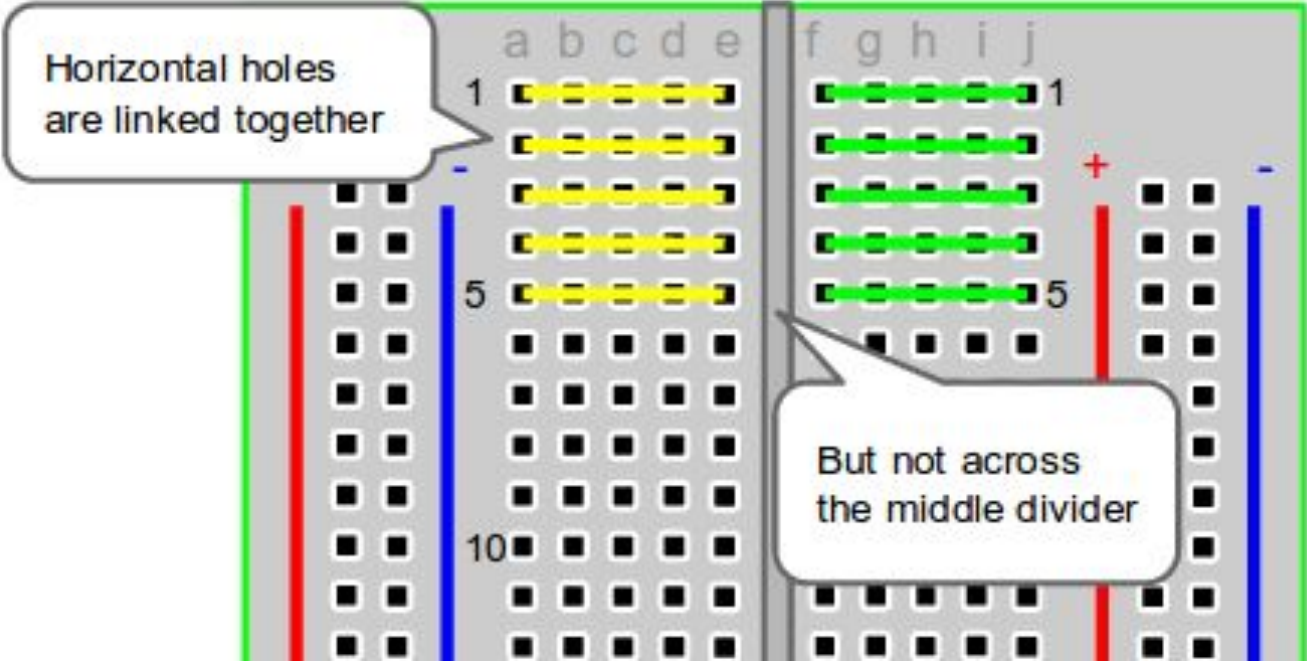


What components? **Same**

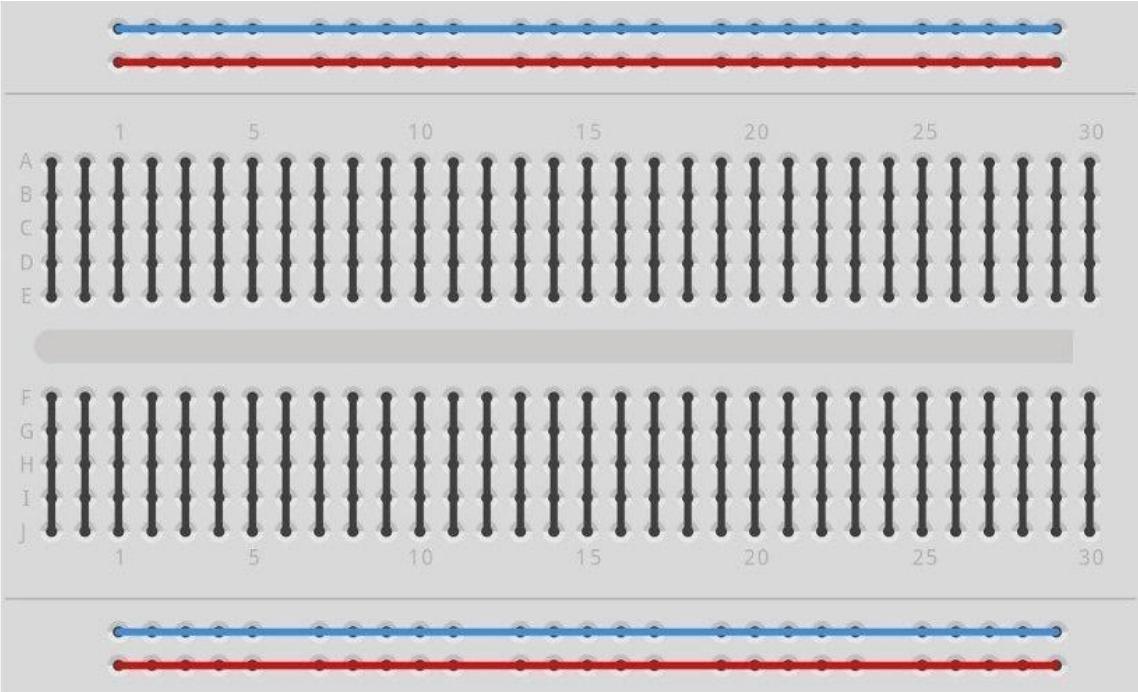
How many nodes? **3**

Where are these nodes?

# Breadboard



# Breadboard

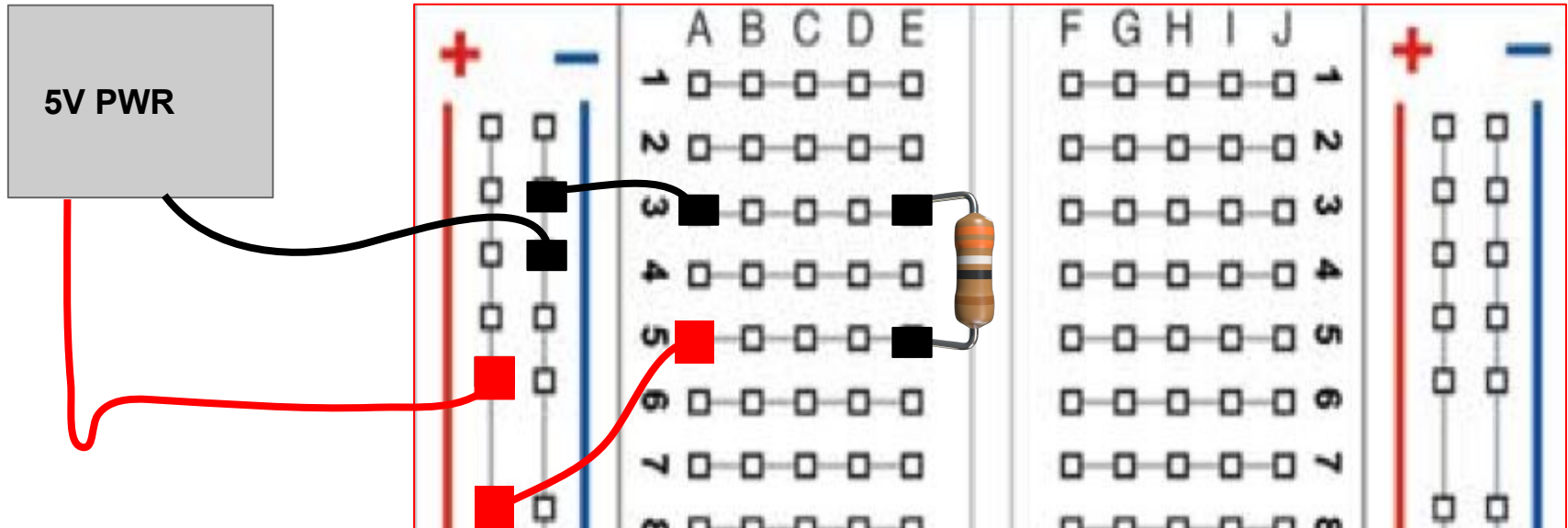
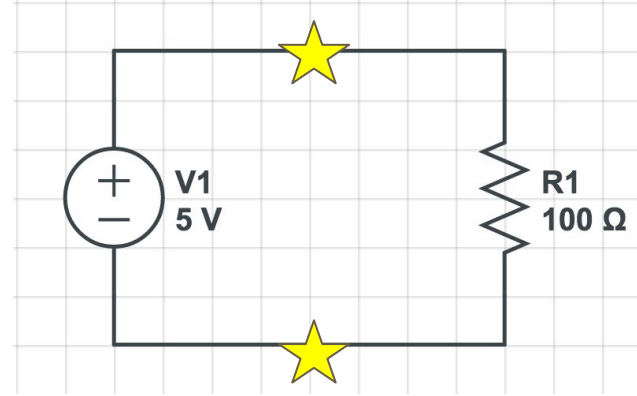






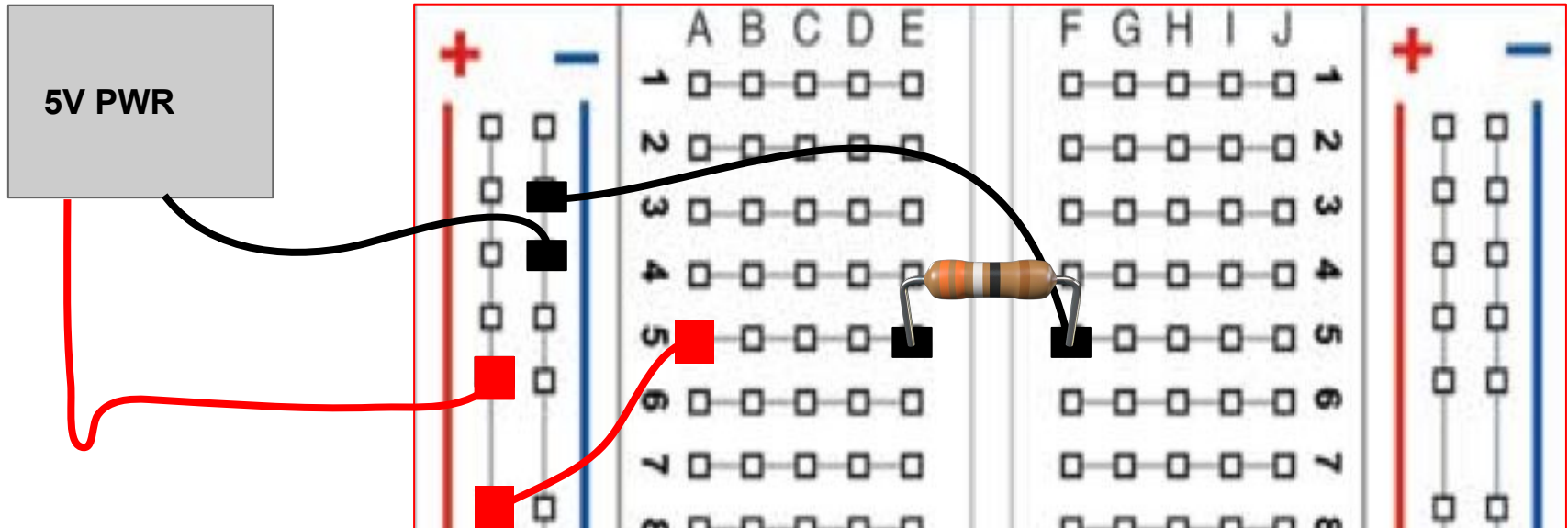
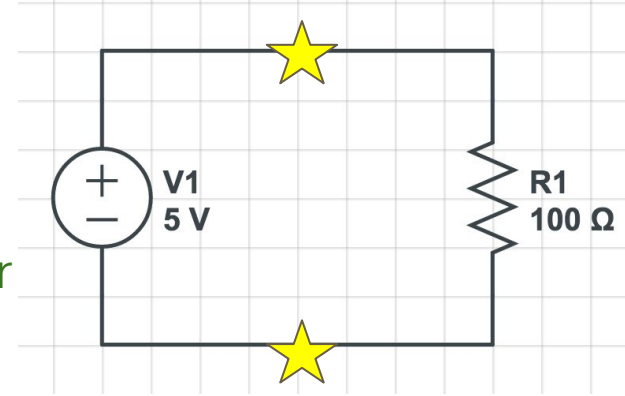
# Breadboard Do's and Don't's

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



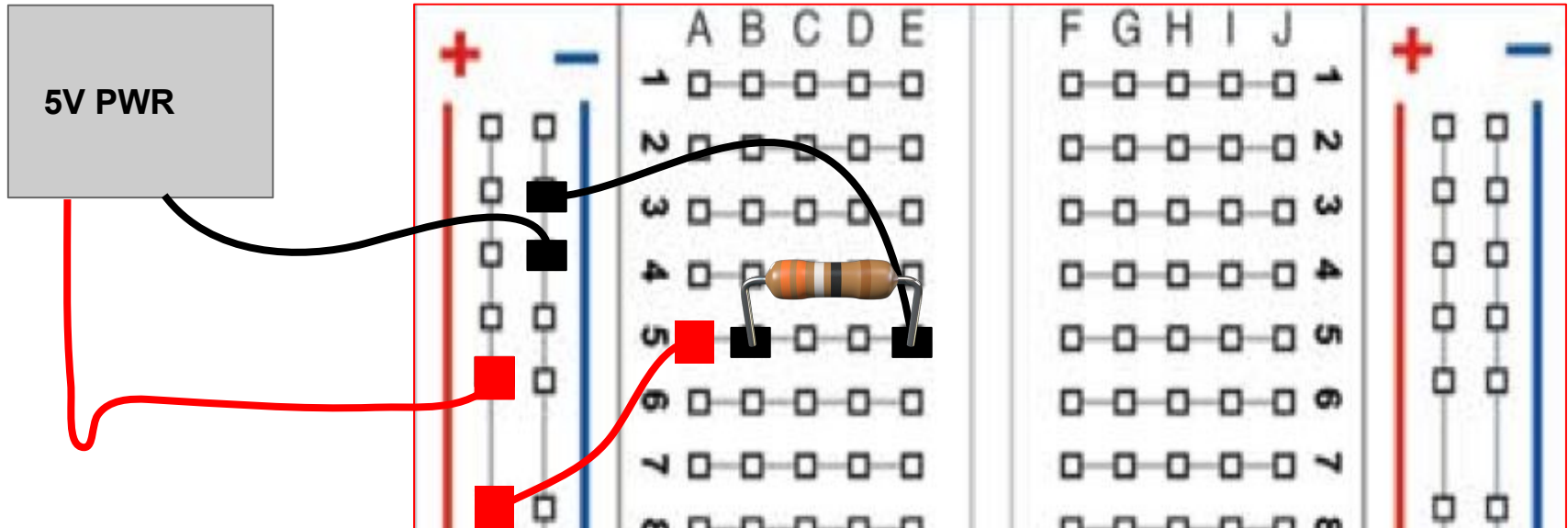
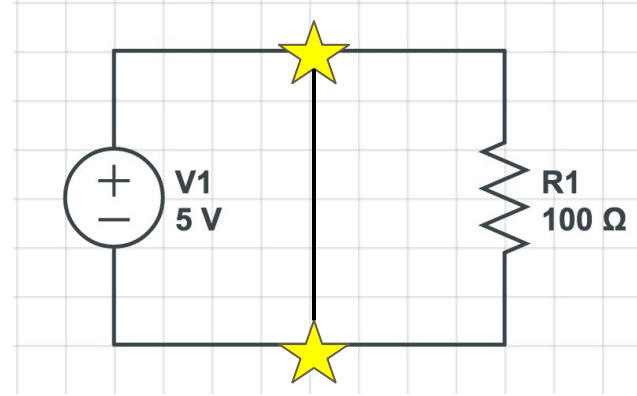
# Breadboard Do's and Don't's

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



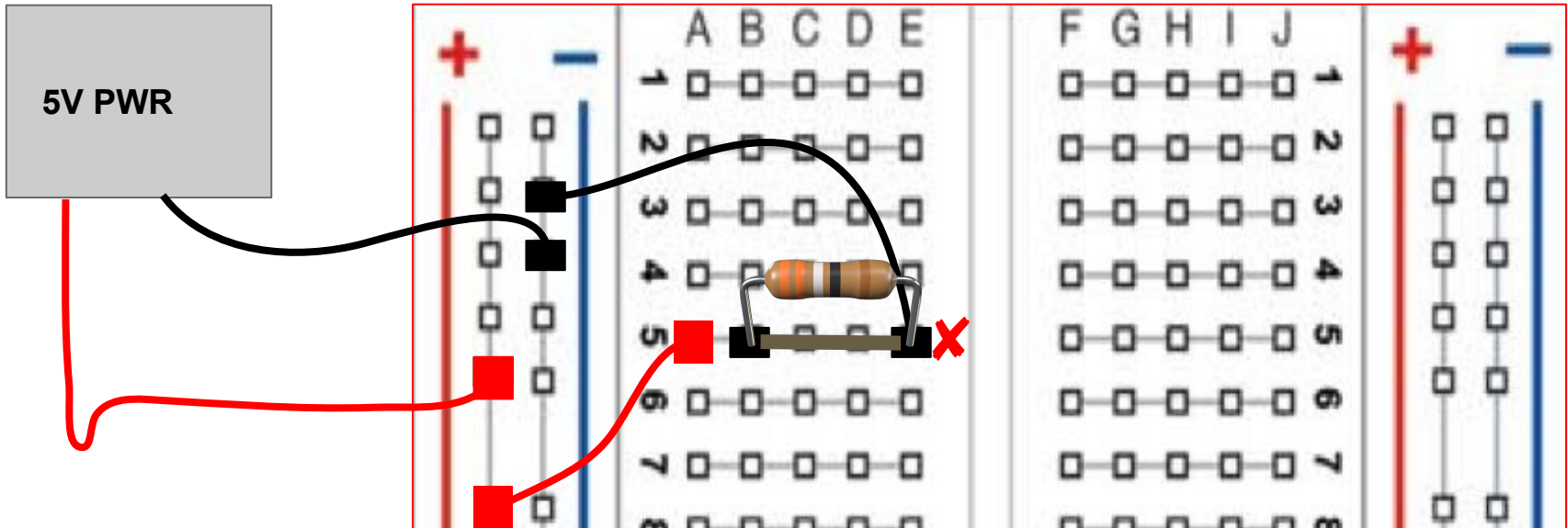
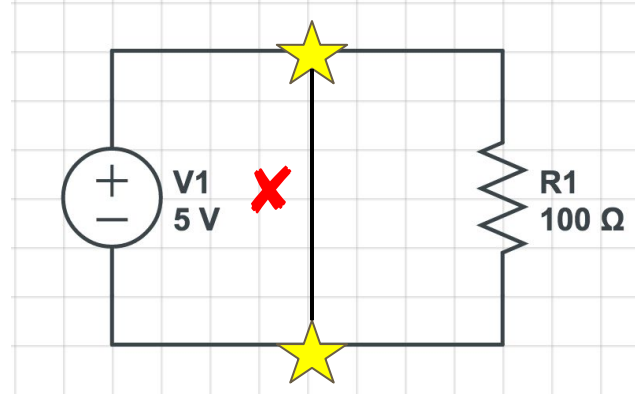
# Breadboard Do's and Don't's

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

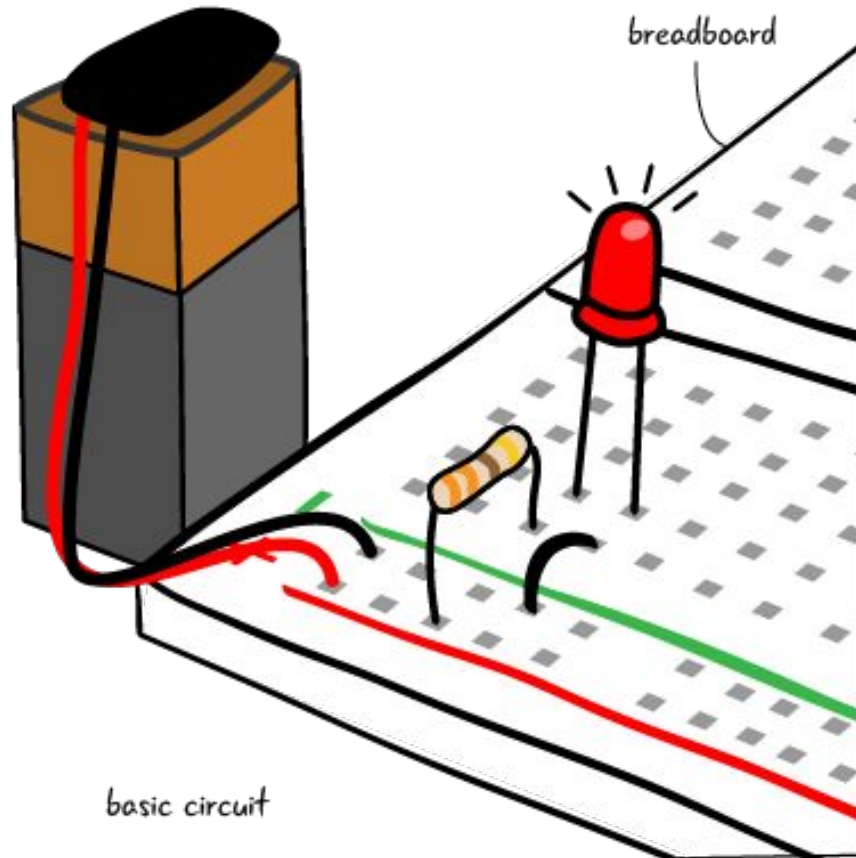


# Breadboard Do's and Don't's

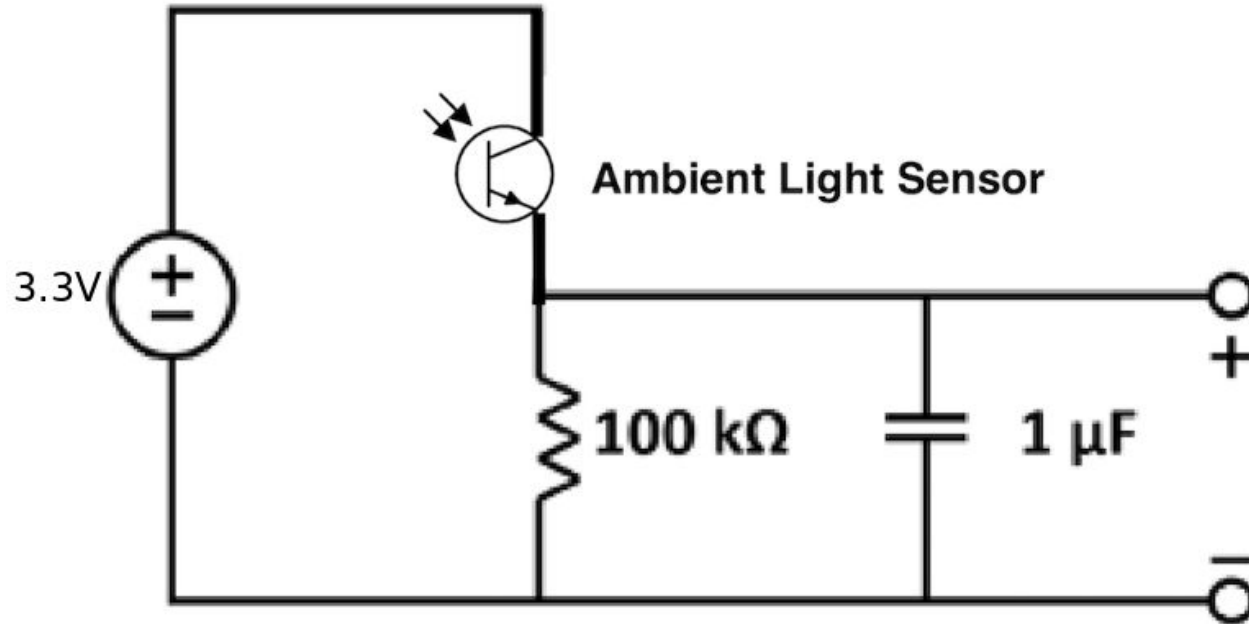
✗ **Do not** plug both ends of component into the same row! This creates a short



# Breadboarding Color Convention



# Light-detecting Circuit

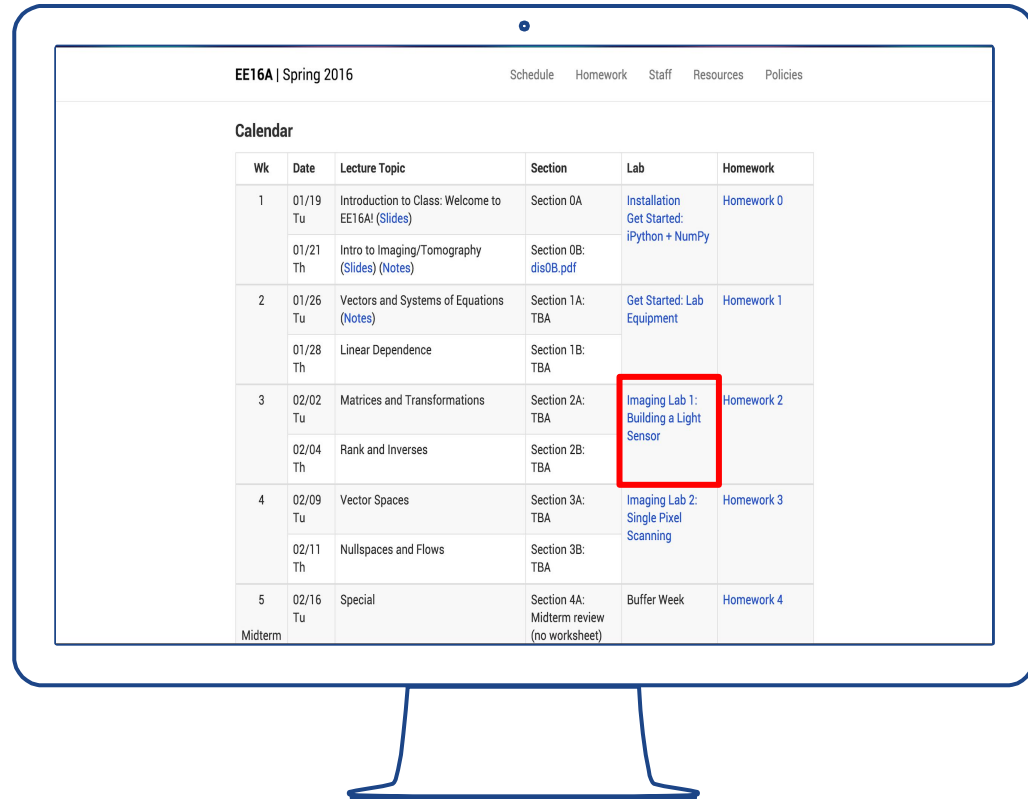


# How to get your lab kit (1 per student)

- After finishing ~20% of the lab you will reach the end of the “Obtaining a Lab Kit” section
- Call over a lab staff member and: (also described in lab notebook)
  - Show answers to PSU, Oscilloscope, and lab kit questions
  - Demonstrate how to use the equipment
  - Be able to name components in the lab kit
- Everything in kit (bag+Launchpad) is yours to keep but **EACH STUDENT HAS TO BRING THEM BACK TO EVERY LAB**

# How to start

- Please use the station desktops for this lab
- If you need an instructional account, let us know
- Work in pairs
- This week's lab is listed as **“Imaging Lab 1”**
- **Make sure website says Spring 2020**



EE16A | Spring 2016

Schedule Homework Staff Resources Policies

Calendar

Wk	Date	Lecture Topic	Section	Lab	Homework
1	01/19 Tu	Introduction to Class: Welcome to EE16A! (Slides)	Section 0A	Installation Get Started: iPython + NumPy	Homework 0
	01/21 Th	Intro to Imaging/Tomography (Slides) (Notes)	Section 0B: dis0B.pdf		
2	01/26 Tu	Vectors and Systems of Equations (Notes)	Section 1A: TBA	Get Started: Lab Equipment	Homework 1
	01/28 Th	Linear Dependence	Section 1B: TBA		
3	02/02 Tu	Matrices and Transformations	Section 2A: TBA	Imaging Lab 1: Building a Light Sensor	Homework 2
	02/04 Th	Rank and Inverses	Section 2B: TBA		
4	02/09 Tu	Vector Spaces	Section 3A: TBA	Imaging Lab 2: Single Pixel Scanning	Homework 3
	02/11 Th	Nullspaces and Flows	Section 3B: TBA		
5	02/16 Tu	Special	Section 4A: Midterm review (no worksheet)	Buffer Week	Homework 4
Midterm					



# FAQ

- **Remote:** Complete the lab in **GROUPS OF 4** in your assigned breakout room
  - You must each build your own setup and answer all questions in your own notebook
- **In-Person:** Complete the lab in **PAIRS**, do ONE setup and notebook per group
- Speak to the TA if you do not have a partner and would like one
- Use the help queue and google checkoff form (linked in the lab)
  - [Lab.eecs16a.org](http://Lab.eecs16a.org)
- **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
  - Female 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
- Check following slide for common Energia Install errors and possible fixes

# Common Energia Install Errors

- **Error:** The system cannot find the file specified
  - Fix: Manually update your board from version 1.0.6 to 1.0.7 (Tools --> Board --> Boards Manager --> Energia MSP430 Boards --> Update)
- **Error:** Serial monitor not displaying anything
  - Fix: select correct Baud rate in the serial monitor window (refer to lab notebook); press RST (reset) button on LaunchPad
- **Error:** Serial monitor displaying strange symbols
  - Fix: close serial monitor; reupload the code to the other COM port and open serial monitor again.
- **Error:** not detecting the launchpad as a launchpad (something like COM3 and COM4 show up)
  - Fix: if on Windows, make sure to install drivers <https://energia.nu/guide/install/windows/>
- **Error:** If you have a space in your Windows username and you encounter an error when running the program, follow these instructions (courtesy of a 16B student's Piazza post)
  - Energia stores some important stuff in this directory `C:\Users\First Last\AppData\Local\Energia15`  
- note: username has a space
  - Create the following directory structure: `C:\Users\First\AppData\Local`
  - Now copy the Energia15 folder from your actual home directory into the local folder in your firstname only user home directory.