

## PS 12b Lab 1d

### IV Curves

Names:

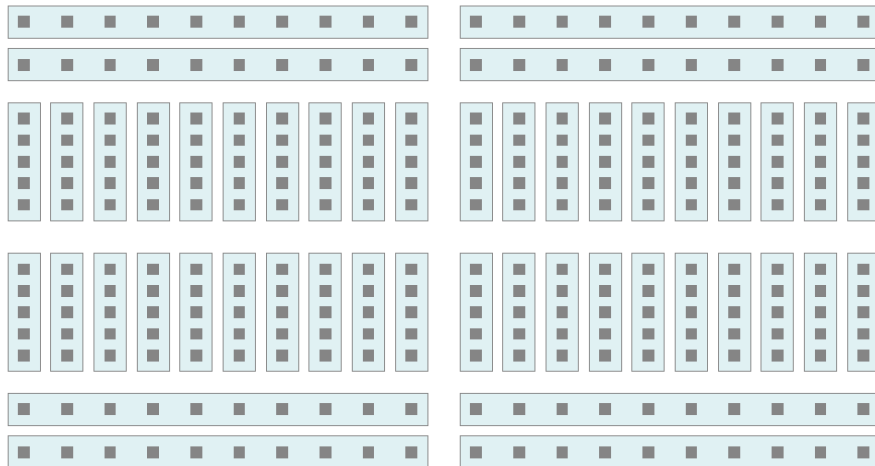
- 1.) \_\_\_\_\_
- 2.) \_\_\_\_\_
- 3.) \_\_\_\_\_

**Learning Goal:** Understand I-V curves for ohmic and non-ohmic devices (light bulb, resistor, Light Emitting Diode (LED), and Thermistor). Work with a Field Effect Transistor (FET) to see how it can operate as a switch.

#### Warm Up:

Build a circuit on the breadboard with a resistor and a light bulb. Use the AC power supply (Function generator) with a 1 Hz triangle waveform to get the bulb to light (careful not to go above 10 volts). Here is a picture of how a breadboard is wired.

1. Use the picture shown below to draw how you would wire up the breadboard to light a bulb. Include where and how the voltmeter and ammeter should be placed to track the current and voltage. Keep in mind the ammeters that we will use prefer to be connected to the ground side of the circuit.



2. Now wire up the circuit to light the bulb.
3. Include the voltmeter and ammeter.
4. Set Logger Pro to take 100 data points per second for 2 seconds.
5. Record some data to make sure everything is working.
6. Try increasing the voltage and repeat.
7. Show this graph and your circuit to the TF to make sure everything is working.

## Measuring Current vs. Voltage characteristics (I-V curves)

### 100 Ohm Resistor

We will first analyze a simple 100 ohm resistive circuit. Replace the light bulb with a 100 ohm resistor. Choose a triangle waveform on the AC voltage source.

- **Question 1:** Imagine measuring Current vs. Voltage using a DC supply. How does using an AC supply instead of a DC supply make the experiment easier?

- Measure voltage vs. current for a 100 Ohm resistor. **Sketch the voltage vs. current graph.**
- From the graph determine the resistance of the resistor. How did you find this?

### Light Bulb

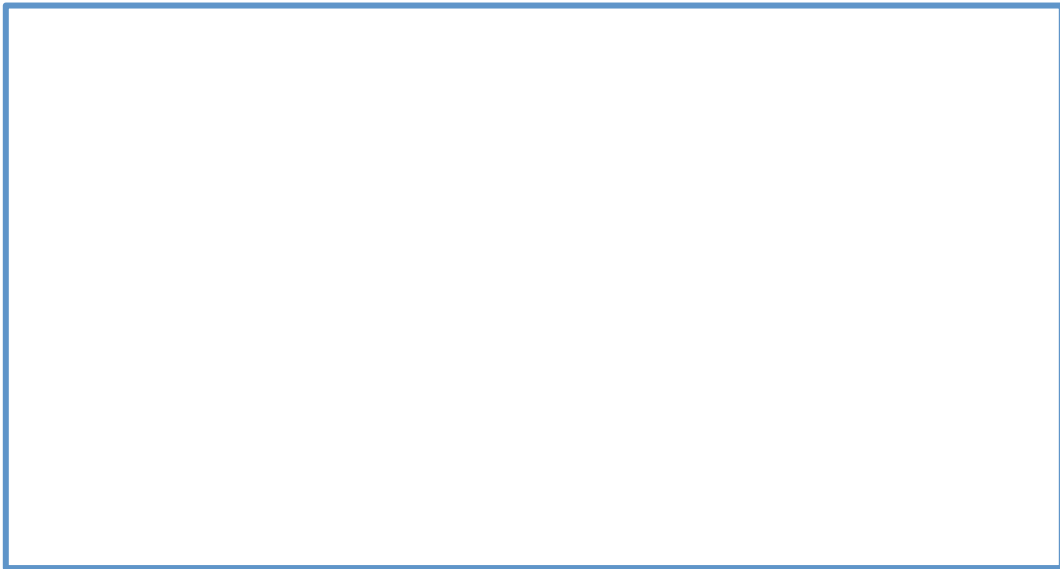
Now replace the resistor with the light bulb provided. Take the data at a very slow frequency so that you can watch how the curve is traced.

- **Sketch the voltage vs. current graph for the light bulb.**
- **Explain why the curve is different than a simple resistor. How does heating and cooling play a role in the behavior of the bulb?**

### **LED (Light emitting diode)**

Replace the light bulb with the light emitting diode and explore its IV characteristics.

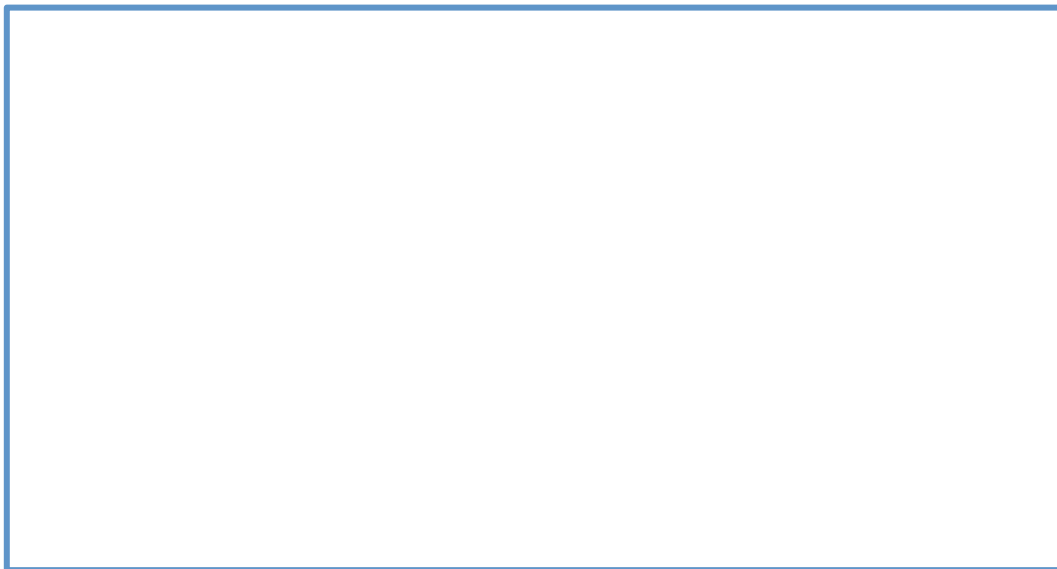
- **Sketch the voltage vs. current graph for the LED.**
- **Explain the characteristics of the LED graph here. What does this imply about the direction the current can travel?**



### **Thermistor (Temperature dependent resistor)**

Replace the LED with a thermistor. Increase the data collection time to 30 seconds or so. Collect data and try cooling the thermistor with the alcohol pads.

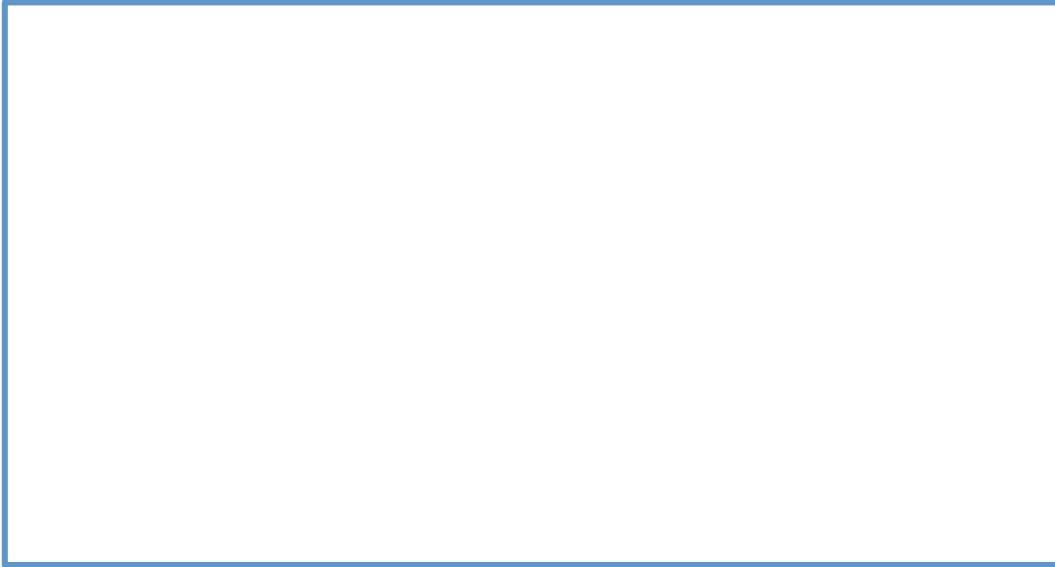
- **Sketch the voltage vs. current graph for the Thermistor.**
- **Explain the characteristics of the Thermistor graph here. How is the thermistor similar and different than a resistor and a light bulb.**



### **Open Circuit and short circuit.**

Now repeat the measurement of the IV curve for an open circuit and a short circuit.

- Sketch the voltage vs. current graph for the open circuit.
- Sketch the voltage vs. current graph for the short circuit.
- What do the slopes of these graphs tell us about the circuits?



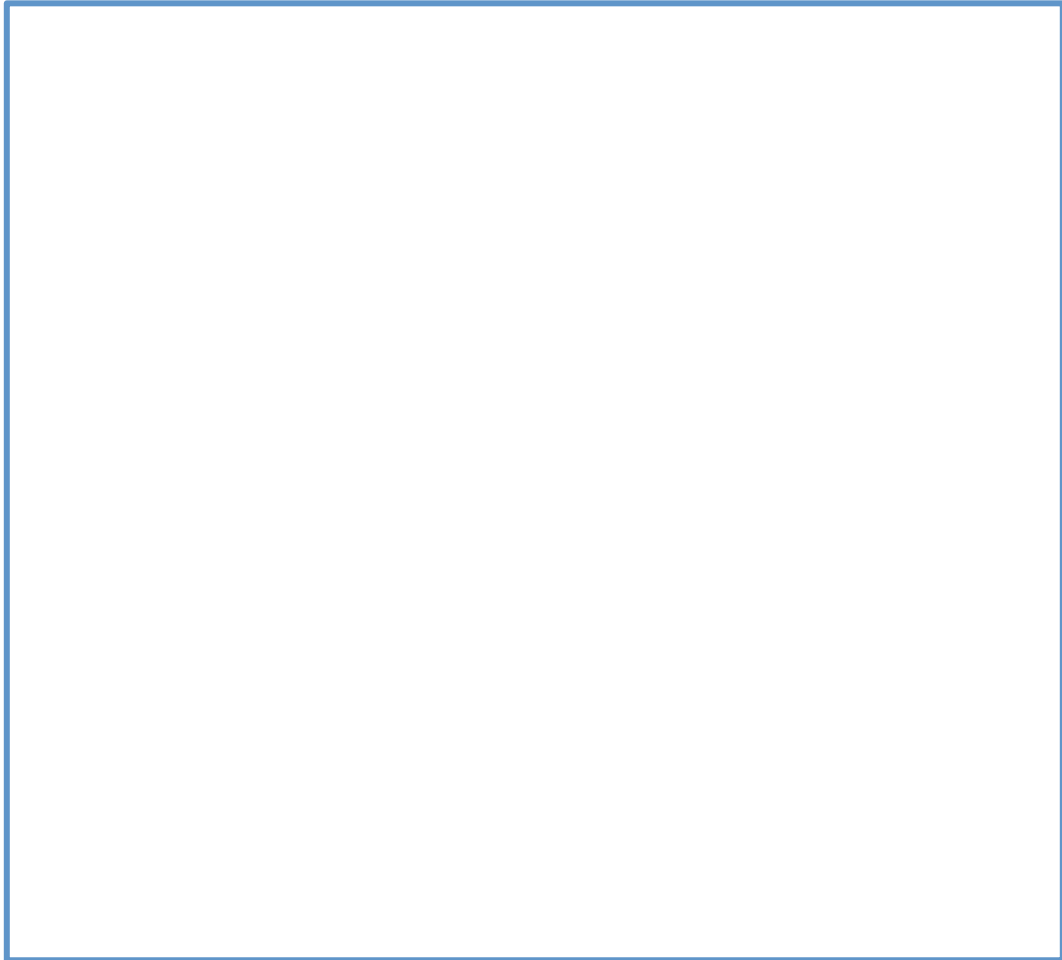
**Classification of the IV curves:**

For each of the IV curves, classify the circuit element as either symmetric/non-symmetric, hysteretic/non-hysteretic, or linear/non-linear by labeling each graph appropriately.

## Black Box Forensics

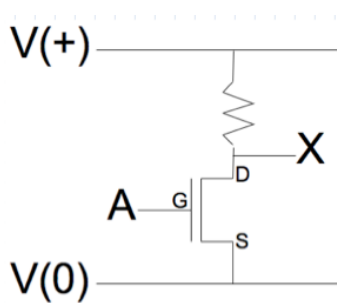
You are given a two terminal device that has been recovered from an Alien spacecraft that has crash-landed in Cambridge Commons. This alien species has limited technology, i.e. its circuits only contain the elements we've analyzed above (resistor, diode, light bulb, etc.). Analyze this two terminal device and determine which circuit elements, or combination thereof, are in the box.

- **Sketch the voltage vs. current graph for the Alien circuit. What do you think is happening and why?**



## Transistors

Build a transistor circuit on the breadboard. Place the drain at a high potential (5 V, using the small “phone chargers”) with a 100 ohm resistor to limit the current. Place the source at the ground. The Gate (input = A) voltage will be switched between the high and the low potential. Watch the output of the circuit by placing an LED by connecting it between X and ground.



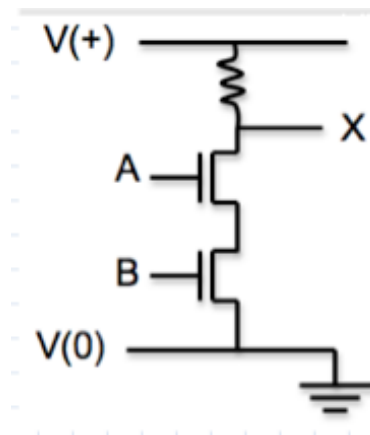
- If the LED is on what does that say about the voltage at X? What if it is off?

- A binary number can is a number that can represent either zero (0 volts) or one (5 volts). Complete the following truth table, using these conventions.

Input A	Output X
0	
1	

**Challenge: Build the following circuit and create a truth table for a circuit with two inputs and one output.**

A	B	X
0	0	
0	1	
1	0	
1	1	



**This circuit correspond to which of the following logical operations.**

**OR, XOR, NOR, AND, NAND, NOT**