Department of
ELECTRICAL & COMPUTER ENGINEERING
THE UNIVERSITY OF UTAH

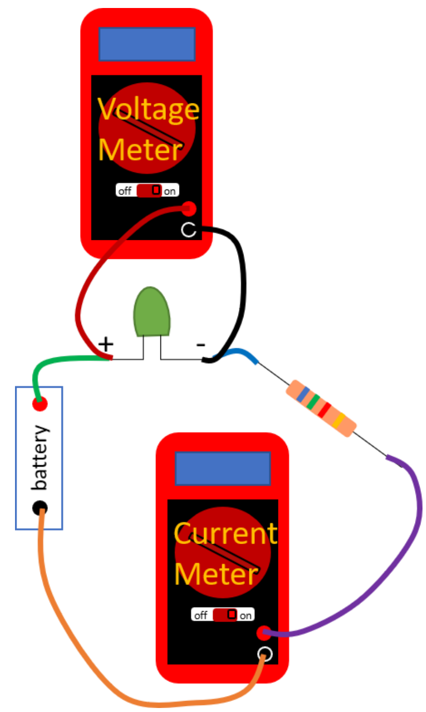
Exponentials and LEDs

Overview:

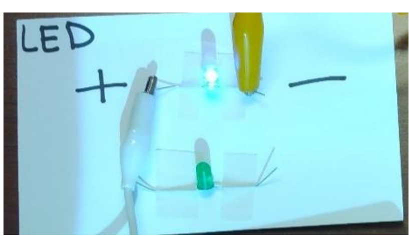
Electrical devices work through the flow of electrons, which are charged particles. For an electrical circuit to work, it must have something that provides power (like a battery), something that consumes power (like a resistor or LED), and wires must connect everything in a circle, so the electrons can flow. The battery has a given *voltage*, which provides the "umph" needed to get the electrons flowing. We call the flow of electrons *current*.

Some electrical components obey linear laws and others, like the LED, have more complicated relationships between voltage and current. Electrical engineers often represent the behavior of different circuit components by plotting their i-V curves, which is a graph relating current and voltage for that particular electrical component. Today we are going to create i-V curves for various color LEDs. By comparing these various graphs, we will better understand how different parameters of the exponential equation affect the curve.

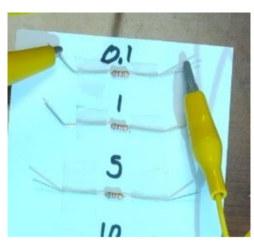
1) Build the following circuit, which has a battery, resistor, green LED, and current meter in a loop. (Whenever we work with LEDs, we must also include a current-limiting resistor.) The + side of the LED must connect to the red side of the battery. Then connect the voltage meter across the LED to measure the voltage of the LED. This will give you a single data point of voltage and current. We will collect 3 different data points by changing the resistor (which lets you change the current and voltage). Then record a final data point with the batteries removed from the circuit. Record your 4 data points below.



LED card



Resistor card

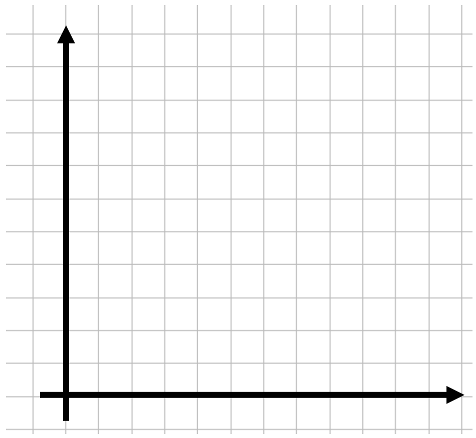


Connect batteries with red side in the same direction

Resistor 0.1:	Resistor 1:	Resistor 5:	No Batteries:
Voltage =	Voltage =	Voltage =	Voltage =
Current =	Current =	Current =	Current =

2) As current increases, the LED gets BRIGHTER or DIMMER or NO CHANGE. (circle one)

3) Graph your points with voltage on the x-axis and current on the y-axis. Don't forget to label your axes. Draw a curve through them that best represents the trend (it should be an exponential).



4) i) Which equation best represents the situation? (a and c are constant coefficients)

   a) $\text{current} = a \cdot 2.7^{\text{c}\cdot\text{voltage}}$

   b) $\text{current} = a \cdot 2.7^{\text{c}\cdot\text{voltage}} + 1$

   c) $\text{current} = a \cdot 2.7^{c\cdot\text{voltage}} + a$

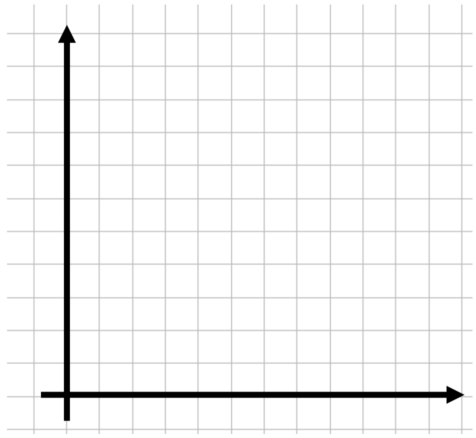
   d) $\text{current} = a \cdot 2.7^{c\cdot\text{voltage}} - a$

   ii) Why?

5) Now repeat the experiment with the blue LED (it is the LED with a clear cover). Record the data you collect below.

Resistor 0.1:	Resistor 1:	Resistor 5:	No Batteries:
Voltage =	Voltage =	Voltage =	Voltage =
Current =	Current =	Current =	Current =

6) Plot the data for the blue LED just like you did for the green LED. Don't forget to label your axes. Again, draw a curve connecting these points that best represents the trend. Redraw the curve for the green LED on this same graph using a different color or a dotted line.



7) Describe the difference between the graph for the blue LED and the green LED.

8) LEDs can generally be represented by an exponential equation of the form $y = a(2.7^{cx} - 1)$. How does the coefficient a compare for the blue and green LEDs (assuming c stays the same)?

The a coefficient is BIGGER or SMALLER or THE SAME for the blue LED. (circle one)