

Name:

Physics 589 – Electricity – Summer 2013

1 Lime Lights!:

1.1 Theory

You will show that voltages of batteries add in series.

You will note that there is a minimum voltage to light an LED.

You will see that LEDs have polarity (it matters which way is positive).

1.2 Materials

LED and resistor kit

Get at least 4 limes (or lemons). Get four 3" lengths of #10 bare copper wire and four large paper clips (iron nails would probably work as well).

Small red LED.

1.3 Make an LED light

Note that your LED has legs of different lengths LEDs are "polar" components. Unlike ordinary light-bulbs, they will only light if the correct end is attached to the positive terminal of the battery. Usually the positive terminal of the LED is the one with the longer wire on it.

Solder a resistor to the positive leg of the LED Your kit came with resistors and LEDs. Pick a resistor. Because the resistor and the LED are in series, it does not matter which leg you attach the resistor to, but we are just keeping track, so solder it to the longer leg you found in the previous step. To solder, first twist together the resistor wire and the LED wire. (Resistors are NOT polar, so there is no "correct" end of the resistor). After you have twisted the pieces together, add a drop of solder. It only needs a little bit.

Light the LED Now use your alligator clips and connect the free resistor lead (the part not attached to the LED) to the positive battery terminal and connect the the free LED lead (the short one, the one you did not solder to) to the negative battery lead. If the LED does not light instantly, disconnect the battery!

Troubleshooting If the LED did not light, either you were shorting it out with your alligator clip or you attached it backwards. The two wires on the bottom of the LED are very close together. Make sure they are not touching. Also make sure your alligator clip connected to one lead is not ALSO touching the other lead. Now connect to the battery again and it should light. If it does not, try connecting the resistor to the negative end of the battery and the free lead of the LED to the positive end. Does it light now?

Connect it backwards Now that you made the LED light, reverse the leads (connect what was positive to the negative and what was negative to the positive end of the battery). Now the LED will not light. LED stands for Light-Emitting Diode. "Diodes" only conduct current in one direction. They have the specific property of blocking current if they are connected "backwards". They are like a one-way valve for electrons. (In Bio you probably teach that arteries have little flaps that prevent blood from flowing, diodes prevent electrons from flowing backwards.)

Writeup The only writeup needed here is a photo of your battery and your lit LED.

1.4 Measure Potential of a lime-battery

Select ANOTHER Red LED The previous section was warm up for this section. You will use a different LED because you DO NOT WANT a resistor on this one (the battery would have burned out the LED without the resistor, but your limes will not and you don't want the resistor wasting your "lime energy"). I have noticed that the Red LEDs light more easily than the other colors. This is the reason for selecting red.

Create a lime battery Insert the copper wire and the nail or paper clip into the lime. They should go in at least an inch and they should be under an inch apart, however they should not touch. Measure the potential of this battery and record it. Also record which electrode is positive.

Wire two lime batteries in series If you do this correctly, the total voltage across both limes will be roughly double one lime. If you do it incorrectly, the voltage will either be about the same, or nearly zero.

Measure the current from your battery Change your meter to the current measurement setting. **NOTE:** Immediately after you make this measurement, disconnect the meter so as not to drain your battery. Also, measuring current with a meter is somewhat tricky. I show you how to do this in the video. Make sure you understand how to do it. What do you get?

Wire two more lime batteries in parallel If you do this correctly, the voltage will be the same as one lime battery. Record the voltage.

Measure the current of your parallel battery **NOTE:** Immediately after you measure the current, disconnect the meter. Do not leave it connected very long or you will drain your battery (it's just a lime!). If you do this correctly, the current should be larger than for a one lime battery. Record the current.

Wire three limes in series Connect the LED across the three limes. It may glow very dimly. Turn out the lights to see.

Wire four limes in series Connect the LED across the four limes. The LED should now definitely glow (even if you need to darken the room to be sure). If it does not, you probably got the polarity wrong. Reverse the

wires to the LED. What is the polarity of the LED? Does the longer lead need to be connected to the positive or negative terminal of your battery.

Make it brighter! Do more limes in series help? How about two sets of four in parallel? Read up on batteries. What else might help (even if you can't do it with the materials given)

Writeup The writeup consists of answers to these questions plus a photo of your four-lime set-up. A cel-phone photo will do. The lit LED probably will be too dim. This is OK.