Application 2

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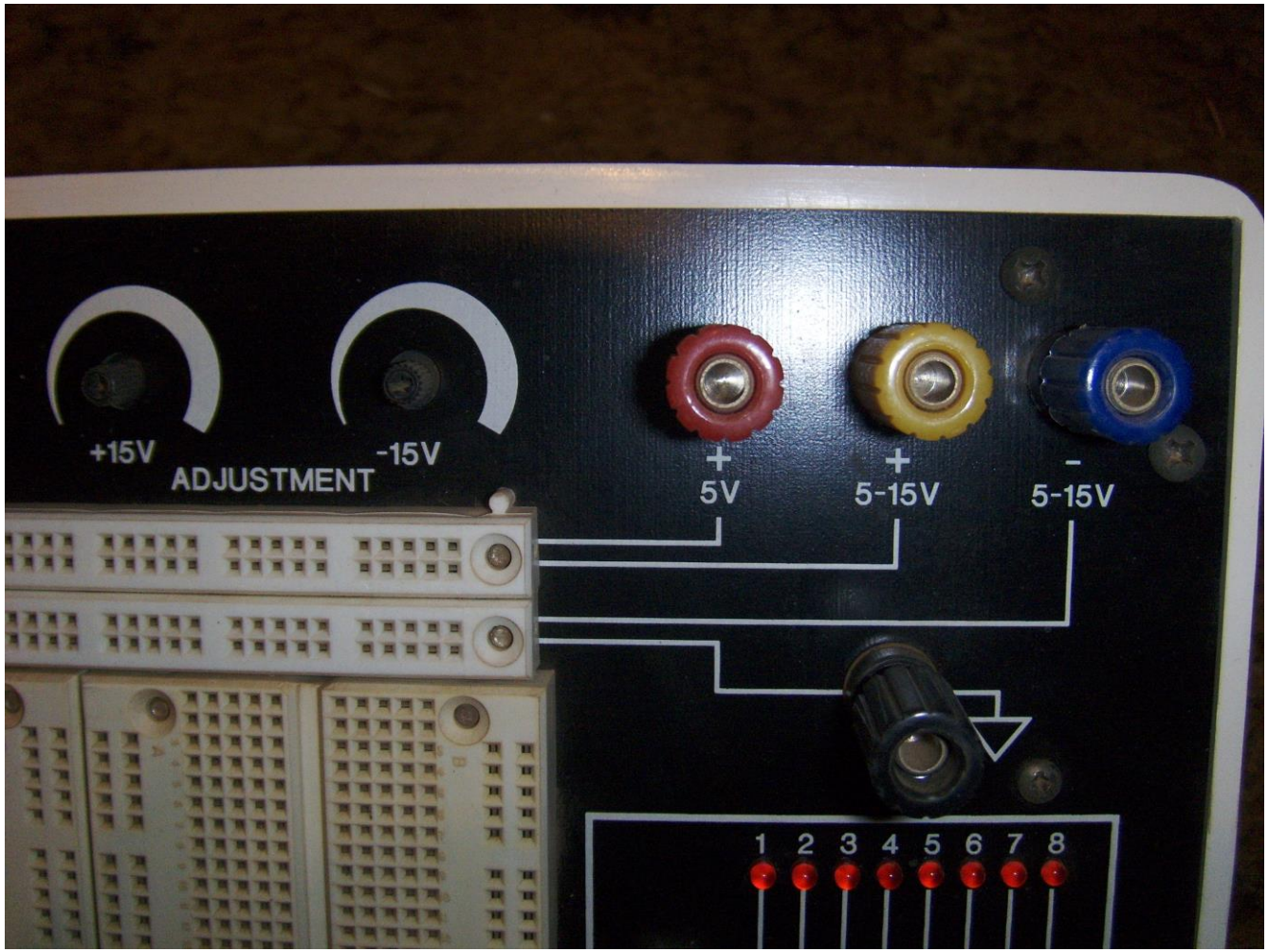
1. Using The Multimeter And The Trainer

a. Plug the trainer power cord into a standard wall outlet (110 vac). Turn the trainer power switch on. Did the light inside the switch come on? What color? _____.



b. Connect the ground/common (black) lead of your personal multimeter to the black ground/common binding post on the trainer. There is a hole in the binding post that will accept the metal probe tip of the multimeter. Finger-tighten the binding post down onto the probe tip.

c. Set the multimeter on the 20 volt DC scale. Touch the red multimeter probe tip to the red binding post. You can do this momentarily by simply inserting the probe into the top of the binding post. Record the voltage that you read here: _____ vdc . Use a wire inserted into half a dozen holes on the top row of holes to prove to yourself that the red binding post is in fact connected to the top row of holes.

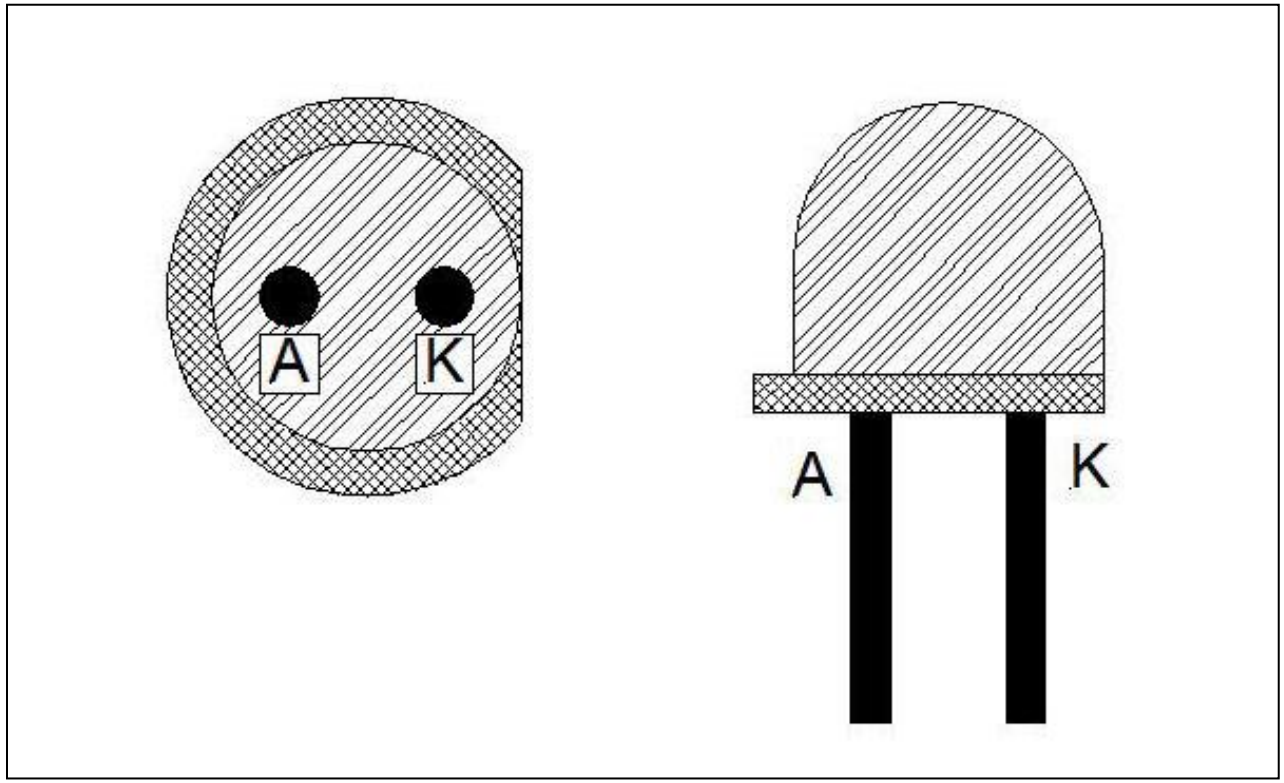
d. Move the red probe from the red binding post and put it onto the yellow binding post. Turn the +15 control fully counterclockwise. Record the voltage here: _____ vdc. Now rotate the +15 control slowly clockwise. Did the voltage "cut out" at any point in the rotation? _____ (it should NOT have unless the control is worn). What is the maximum voltage obtainable with the +15 volt control in the maximum clockwise position _____vdc. Take a wire (see step c) and check the second from the top row of holes to prove to yourself that the yellow binding post is connected to the second row of holes.

e. Similarly, move the red probe onto the blue binding post. Record minimum _____ and maximum _____ voltages available from the -15 supply (note -- you should record the voltages as NEGATIVE with a minus sign in front of them).

2. Exploring LEDs

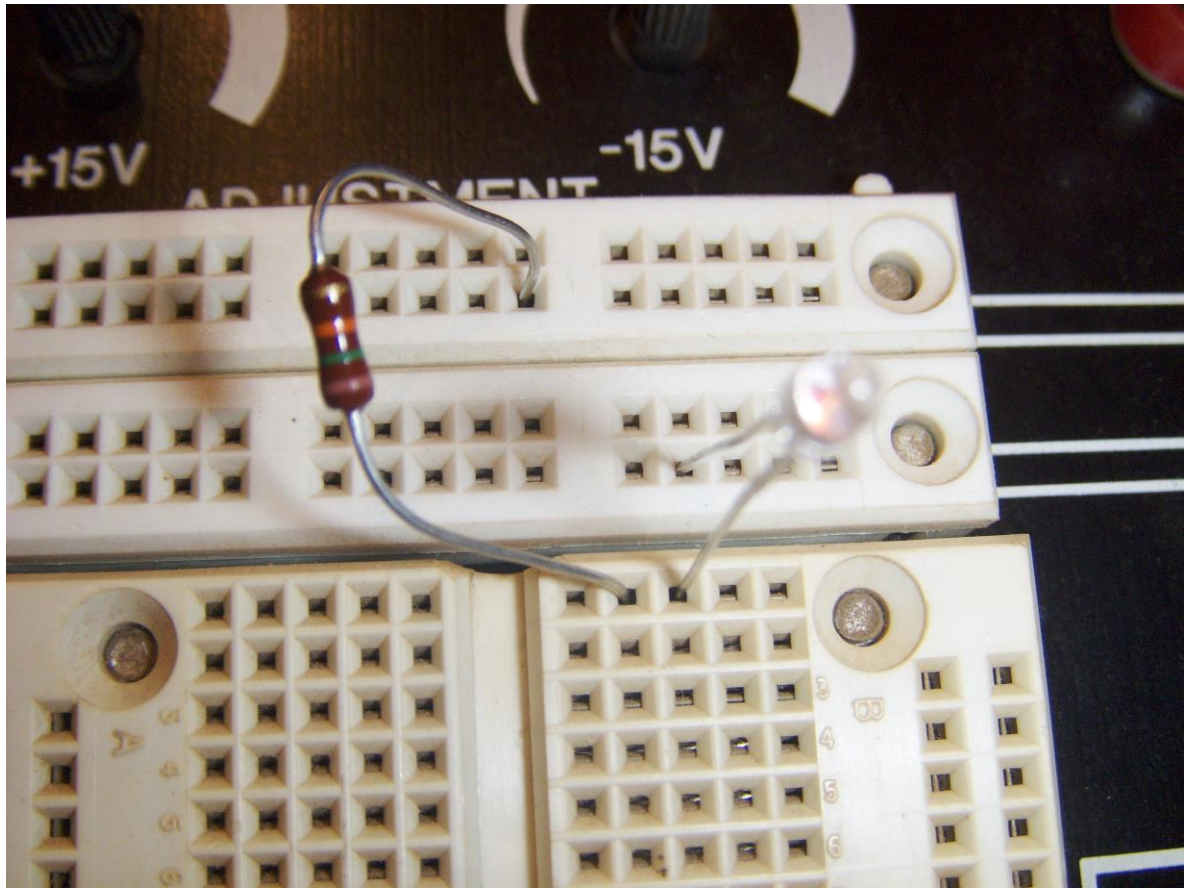
a. As we mentioned in class, LEDs come in many different colors and sizes. And, even within colors the plastic housing around the LED chip itself may be either water clear (no coloring whatsoever), transparent (a very light tint of the same color as the LED) and diffused (a deep tint of the same color of the LED that you cannot see through).

There are two leads on an LED, the anode (A) and the cathode (K). By running current through the (positive) anode out the (negative) cathode we can cause the LED to emit light. Here is a top and a side view of an LED:



Note that the "skirt" (bottom of the LED) has a FLAT on one side of it. This positively identifies the cathode end of the LED. As shipped from the factory, the cathode wire lead is shorter, but you cannot guarantee that somebody didn't clip the anode lead from the LED and put it back into the stock bin.

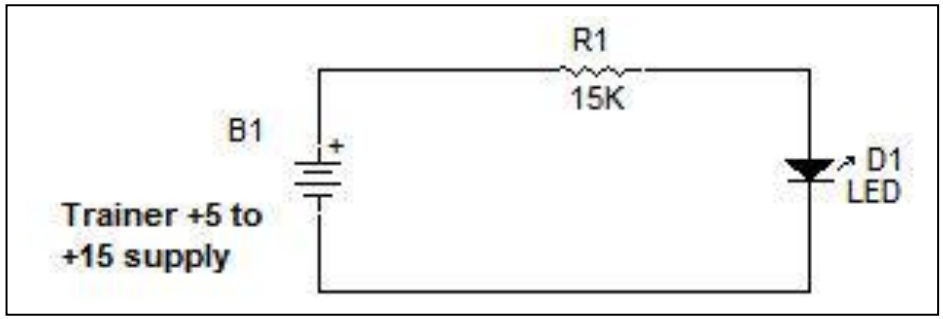
b. In order to better see the actual color of the LED chip, we are going to use water clear LEDs. However, this means that you MUST positively identify the color of the LED that you have used and put it back in the SAME tray you took it out of. Next semester's students will be very angry if the LEDs get mixed up in color. When the lab is over, light the LED, confirm the color and take that ONE led and put it back in the tray, then the next, and so on until all 4 colors have been put away properly.



c. There are four colors of LED that we are going to use today: red, white, yellow, and green. Each lab "team" needs to get one each of the four colors from the four trays on the front desk **ONE LED AT A TIME**.

d. You will also need a 15,000 ohm (15kΩ) resistor. The color code for this resistor is brown-green-orange-gold. The decoding is brown (1), green (5), orange (add 3 zeroes), gold (±5%). Thus we have a 1 5 000 ohm resistor. MEASURE the resistor using your multimeter to prove to yourself that you do in fact have a 15kΩ part.

e. In order to see the actual chip itself, we are going to have to run a very low current through the diode, something less than a milliampere and more like a couple of hundred microamperes. Above these levels, the chip is FAR too bright to be easily seen and examined. The schematic circuit looks like this:



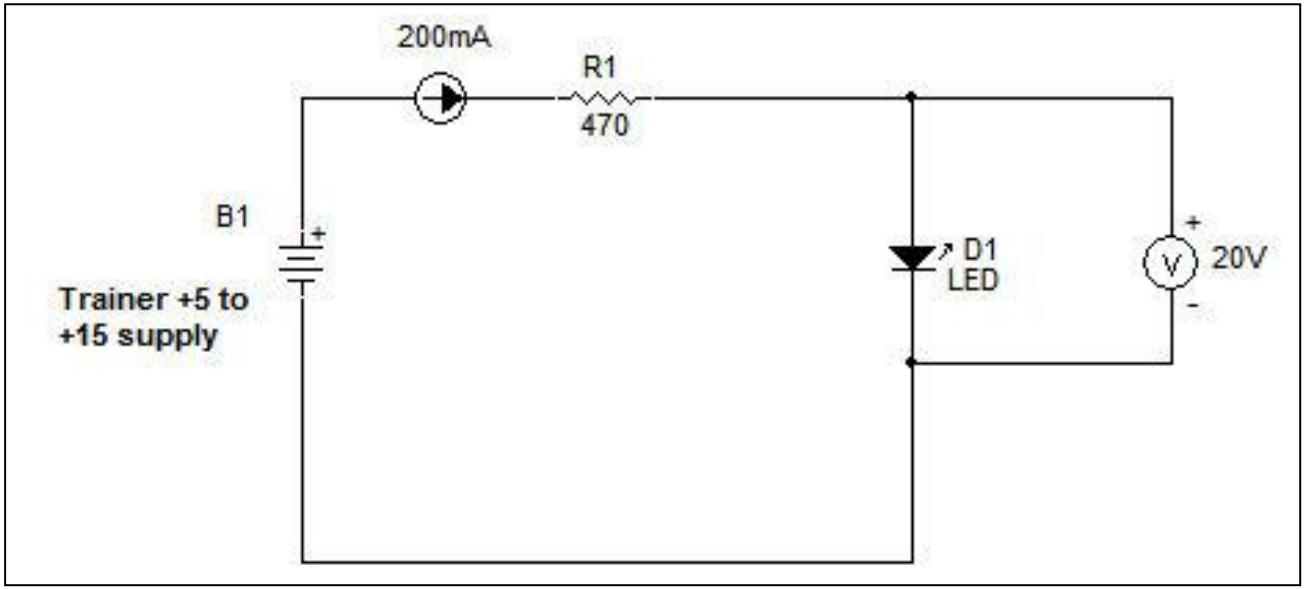
f. There must be a dozen different ways to hook this circuit up on the trainer. This is just one way:

g. If you look very, very carefully at the clear plastic LED you can see just a faint red glow. That's what you are trying to achieve (with the red LED).

h. Using a magnifying glass or optical hood, look as closely as you can to the little LED chip down at the bottom of the LED package. You should be able to see what looks like a little tiny slice of bread that is glowing all over. Note in the center of the LED that there is a wire connected to the chip. That is the wire that is going to the anode lead coming out of the package on the bottom. You may if you like adjust the +15 volt power supply for the best view. Look at all 4 colors. Other than the color do they look all alike?

i. Turn the +15 adjustment control all the way DOWN (dimmest light) and the trainer power switch off.

j. Now let's make that LED do some real work. Most small LEDs are rated 30 milliamperes (0.030 amperes) maximum current and most of the published specifications are taken at 20 mA (milliamperes). Now we know from lesson 2 that a current meter (ammeter or milliameter) has to be inserted in SERIES with he circuit to measure current and that a voltmeter has to be inserted in PARALLEL with the part that you are measuring the voltage across. Here is the schematic of that arrangement:



k. Use your own personal multimeter for the current meter and one of the big confusing lab multimeters for the voltage meter. You will probably want to use some wires and alligator clipleads to hook all this up so that all you have to do is pop the LEDs in and out of the trainer to take these measurements.

l. You also have to change the resistor value from 15kΩ to 470Ω (yellow-violet-brown-gold). See if you can use the wall chart to figure out why this color code is correct.

m. Now turn the trainer power switch on and slowly increase the current to 20 mA as read on your multimeter. Fill in the table below with your voltage values:

Color	Current (mA)	Diode Voltage
Red	**20**	
White	**20**	
Yellow	**20**	
Green	**20**	

n. Now purely as a SUBJECTIVE measurement, have one lab partner rapidly switch **colors** (except for white) and the other lab partner(s) secretly write down the color they thought was the brightest of the three. Then swap places and see if you both (or all three of you) agree on which one was the brightest. Or, if you are REALLY trying to make the determination, get rid of the voltmeter and ammeter and use 4 each 470 ohm resistors and view all 4 diodes simultaneously with the basic circuit shown on page 3 with the 470Ω in place of the 15kΩ.

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