LAB #2: Fun with DC Circuits
Physics 2020, Fall 2004

The field of electronics has revolutionized the way we live and what we do. We can find circuits everywhere—from our cell phones, digital watches, calculators, televisions, computers, etc. Understanding how these things work is interesting in their own right, but from this we can figure out how to do more practical things, like design and install our own car stereo system or make sure that we *do not* electrocute ourselves.

In this lab, we will first look at a few simple DC circuits that will give us an idea of how these things work in the first place. We will learn how to use a DC power supply and an electrician's best friend—a digital multimeter (DMM).

PRELAB QUESTIONS:

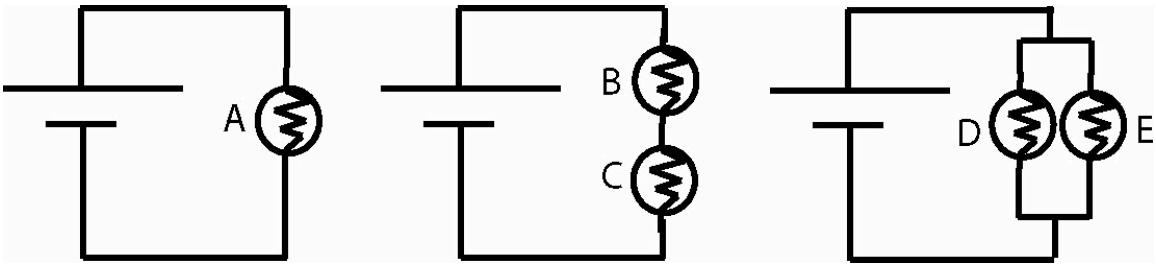
TURN THIS PRELAB IN ON A SEPARATE SHEET OF PAPER

1. Read the lab thoroughly.

2. Familiarize yourself with circuits and circuit diagrams in your book. Chapter 19-1 to 19-5.

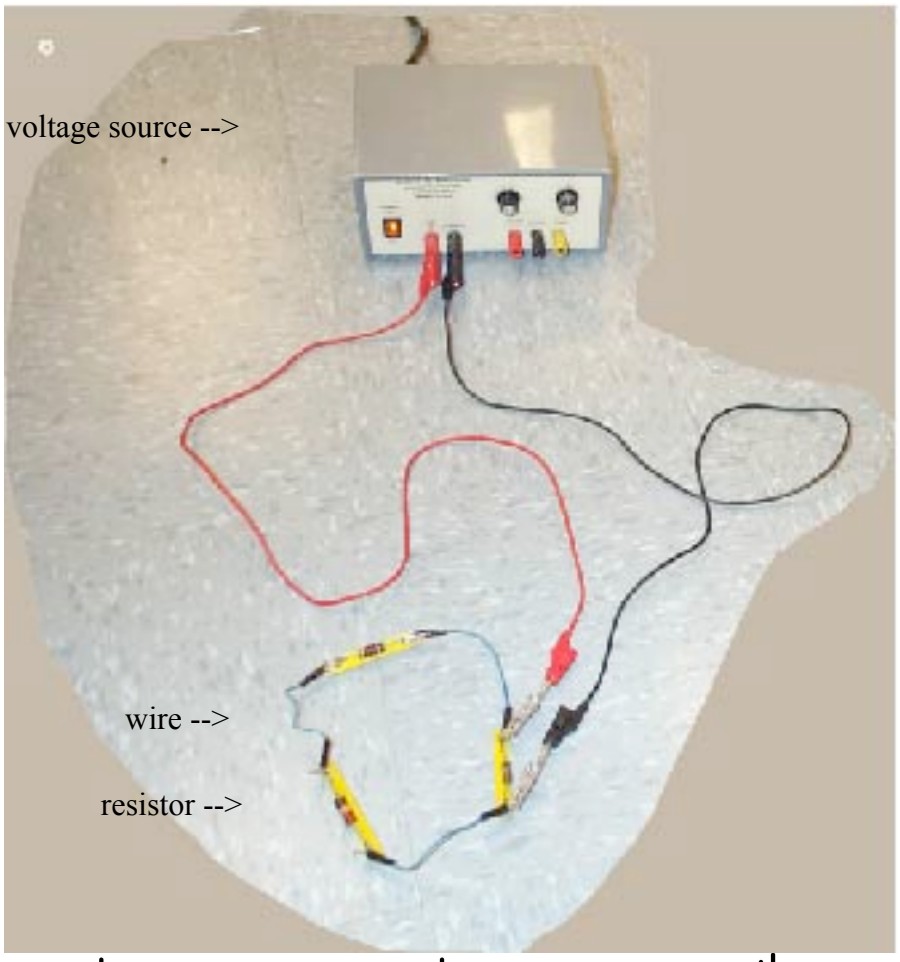
3. Thought experiment: Can you use a SINGLE lightbulb SINGLE battery and SINGLE wire, and can get the lightbulb to light? Answer this on a separate sheet and Draw a diagram

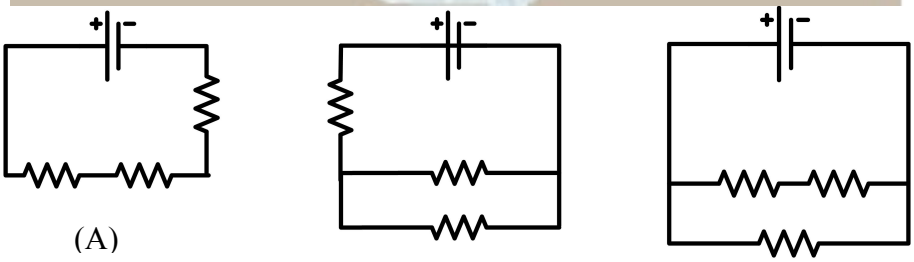
4. For the circuits below rank the relative bulb brightness from brightest to dimmest. Note all batteries are identical and ideal. All lightbulbs are identical and ideal. Note also that bulb brightness reflects the power dissipated in the bulb and that the bulb is a resistor.



5. In 50 words OR MORE describe WHY the bulbs are ranked as they are. Present your reasoning in every day language so that a friend who has never taken physics would understand your reasoning for why you ranked the bulbs as you did (you can use words like voltage difference, current, energy etc, but no explicit formulas).

6. Look at the picture on the following page. Select the schematic diagram for the resistors and power supply below the picture.

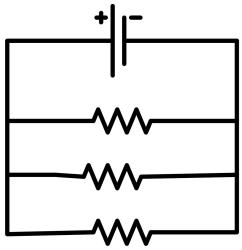




(A)

(B)

(C)



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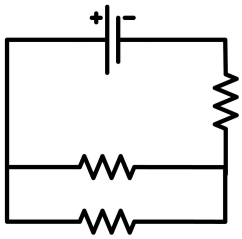
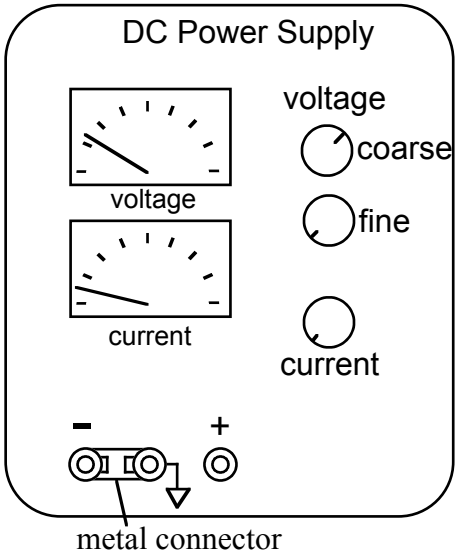


(E)

Lab Activities: PRECAUTIONS & NOTES:

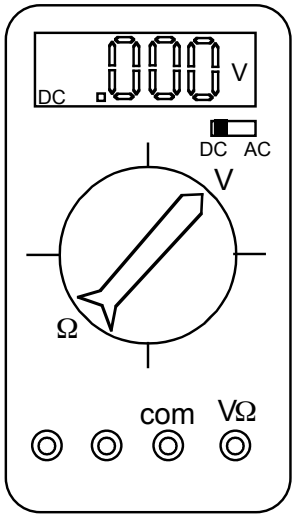


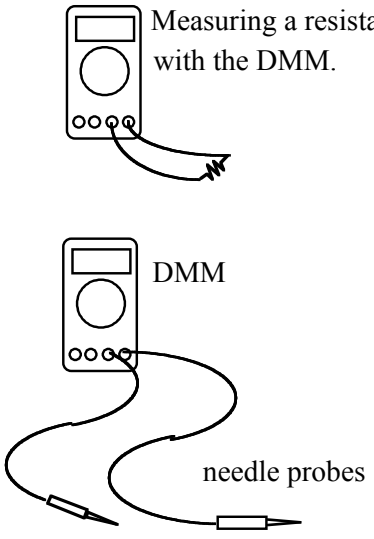
The two instruments you will use in this lab are a DC power supply and a digital multimeter. The DC power supply produces a constant voltage, which can be adjusted anywhere from zero to 30 volts with the voltage knobs (coarse and fine) on the front panel. The power supply has three output terminals: plus (red), minus (black), and ground (green). The ground terminal is always at zero volts. In this experiment, the ground and minus terminals are tied together by a metal connector so the minus terminal is also at zero volts. Both the current and voltage produced by the power supply can be read on meters on the front panel. Also on the front panel is a current-limit knob, which can be adjusted to limit the maximum output current, to prevent damage to sensitive circuit elements. In this lab, the current knob has been set and clamped in place so the power supply cannot produce more than about 0.6A current.

The hand-held digital multimeter (DMM) is a wonderful little device which can be used to measure the voltage difference between any two points in a circuit, the current, and the resistance or capacitance of any circuit component(s). In this lab, we will use the DMM to measure both resistances and DC voltage differences. There are 2 wires attached to the DMM. One of the two wires always goes to the COM (common) terminal. To measure either the voltage difference or the resistance, the second wire is attached to the "VΩ" input. In this lab, all our measurements will be DC, so the DC/AC switch (upper right) should always be in the DC position. The DMM has an alarm; it rings if you have wires plugged into positions which conflict with the central knob's position.

The 2 wires attached to the DMM are called "needle probes". You can quickly measure the change in voltage between any two points in a circuit by touching the points with the needle probes.

When measuring a resistance with a DMM, you must disconnect the source of the resistance from any other devices, such as power supplies. *Never try to measure the resistance of a resistor while it is still in a circuit.*





PART I: MEASURING RESISTANCE

Your goal of this part of the lab is the following: *Figure out how to measure the resistance of various things using the DMM.*

At your table, you should have 5 resistors: one 15Ω, one 40Ω, one 1500Ω, and two 3000Ω resistors. These values are given by the manufacturer and are *approximate*. Each resistor is mounted in a double-banana plug connector. Carefully measure the resistance of each resistor with your DMM and record your measured resistances.

You should also have two light bulbs at your table. Use the DMM to measure the resistance of each light bulb filament, and record your results.

What is the resistance of other things around you? The benchtop, your own self, your lab partner, your lab book, etc. Explore. Are these consistent with how well these materials conduct electricity?

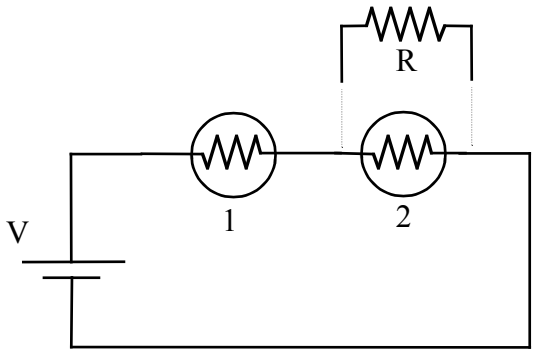
It is up to your lab group to create 2 different resistor combinations using the 5 resistors and 2 light bulbs —both in series and in parallel. Draw a picture of each combo of resistors in your lab book, and *predict* the equivalent resistance of that combo. Measure the resistance of the combo and see if your prediction matches—does it?

PART II: CIRCUIT BEHAVIOR

Now that you understand how to use the DMM, you will now build a circuit and investigate its behavior.

Construct the circuit shown below, consisting of two light bulbs in series with the power supply. (The resistor R will be added later). Slowly increase the voltage until the bulbs are glowing, but not too bright. *Predict* what will happen to the brightness of the bulbs when you place a R = 40Ω resistor in parallel with bulb #2 as shown in the schematic. Go ahead and add in the resistor, and describe in your own words what happened and why. Measure the voltage across the light bulbs and resistor and verify that they match your prediction (i.e., if you know the power supply voltage and all the resistances, do the other voltages make sense?).

Do the same thing for other resistor values and describe what happens in each case.



PART III: MEASURING RESISTANCE IN MULTIPLE WAYS

In Part I of this lab, you learned how to measure the resistance using the resistance feature on your DMM. Go back to one of the circuits that you built in Part II and measure the resistance of the resistor in parallel with bulb #2 *without* using the resistance setting on your DMM. Your group will have to figure out a clever way to do this using the power supply and the other features of your DMM. Describe in detail how you were able to accomplish this.

Note: Besides not being able to use the resistance feature on your DMM, make sure that the light bulbs are still glowing when you take any measurements.