I. Before you come to lab

- Read this write up and the background material.

II. Learning Objectives

In this lab, you'll gain familiarity with circuits by solving two "puzzles" involving measuring some unknown quantities. The key to solving these puzzles will be a good understanding of circuits, both on a theoretical and a practical basis. You will also investigate the behavior of an RC circuit as a function of time.

III. Materials

Differential voltage probe

The differential voltage probe is basically just a voltmeter that interfaces with Logger Pro. Like the multimeter you used in Lab1, it measures the potential at the red probe minus the potential at the black probe.

Selection of alligator clip leads

Large 6 Volt Battery pack

2 Light Bulbs

Selection of resistors

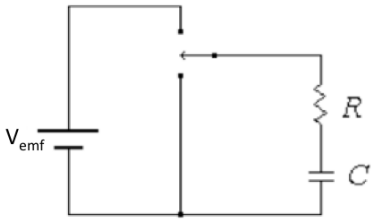
The resistance of a resistor is indicated by the set of four colored stripes on the resistor. For an overview on how to read the value of the resistance from these colored stripes, refer to the supplemental.

1 "mystery" resistor (the one with black tape)

RC circuit board

This is a board wired with the circuit at right, where: R = 30 kΩ, C = 1 μF, and the battery is a standard 1.5-volt AA cell battery.

When the switch is in the up position, the battery is included in the circuit to charge the capacitor. When the switch is in the down position, the capacitor discharges through the resistor. When the switch is in the middle position, no current flows and any charge which happens to already be on the capacitor remains there.



RC Circuit Board

V. Procedure

Who are you? (Picture, full names, and emails please)

A:

Part 1: How bright is the light?

For this part you do not need the RC Circuit Board. Connect the battery to one light bulb by creating a closed circuit between them. Now attach a second light bulb, so it is in series with the first. **What do you notice about the brightness of the each bulb versus the original brightness of one bulb?**

A:

Now detach the second bulb and reattach it so it is in parallel with the first. **What do you notice about the brightness of the two bulbs versus the original brightness of one bulb?**

A:

Which of the three setups (one bulb, two in series, two in parallel) draws the most power from the battery? How much power is drawn in each configuration? Assume each bulb has a constant resistance, R. Talk to a TF about your answer.

A:

Do you think the outlets in houses are wired in series or parallel? Why?

A:

Part 2: Mystery resistor

For this part you do not need the RC Circuit Board. In this part of lab, you will attempt to determine the value of an unknown resistance by designing one or more circuits involving the mystery resistor and making appropriate measurements. Be forewarned: it's not trivial.

The tools you will be able to use to measure the mystery resistor are:

i. a battery pack
ii. a selection of resistors of different (known) values
iii. LabPro interface with differential voltage probe and the Logger Pro software. (Note that the only measurements you can make are *voltage* measurements. You cannot make direct measurements of current or resistance!)

Play around with the components at your disposal and see what you can measure. At some point, however, work with your lab partners to devise a systematic plan to determine the mystery resistance. Then put your plan into action!

Describe your procedure here; be specific! Include snapshots of circuit diagrams if you need to. Feel free to add as many steps as you need. And make sure you zero the differential voltage probe properly (LoggerPro→ Experiment→Zero).

A:

Record your measurements and calculations here.

A:

How can you increase the precision of your measurement? What factors contribute to the overall precision?

A:

What is the mystery resistance R? Call a TF to check your value.

R =

Part 3: Charging and discharging of a capacitor

In this part of the lab you will use an RC circuit board to explore the processes of charging and discharging a capacitor. You will also find the time constant for this circuit. Make sure you familiarize yourself with the RC circuit and the LoggerPro file as described in the "Materials" and "Procedures" parts of the write up before taking data.

Charging RC

Start with the capacitor fully discharged. Connect the differential voltage probe in order to measure the voltage across the capacitor and click on Collect. When you see the message "Waiting for data," throw the switch into the charging position.

What are the "initial" and "final" values of the capacitor voltage?

A:

What functional form does the plot look like? Fit it in Logger Pro.

A:

How long after you throw the switch does it take for the capacitor voltage to go 63% of the way from its initial to final values? Estimate this from your plot, then compare with your fit.

A:

Is this consistent with the stated component values for R = 30 kΩ and C= 1 μF? Explain.

A:

Paste the relevant part of your graph here. Be sure to display the results of your fit:

A:

Discharging RC

Start with the capacitor fully charged. To minimize any error caused by slow discharge (see supplemental and Warm-up for explanation), keep the switch in the charging position until you are ready to throw it into the discharging position. It's okay if the voltage goes down a little bit before the discharging begins; it is as if the initial charge on the capacitor were somewhat lower. Click on Collect and when you see the message "Waiting for data", throw the switch into the discharging position.

How long does it take for the capacitor voltage to become 1/e of its initial value? Estimate this from your plot, then compare with your fit.

A:

Is the time constant the same as it was for charging? Explain.

A:

Paste the relevant part of your graph here. Be sure to display the results of your fit:

A:

VI. Conclusion

What is the most important thing you learned in lab today?

A: