Dr. Fritz Wilhelm
C:\physics\230 lecture\230 lab8 R and RC.docx; 4/22/2010
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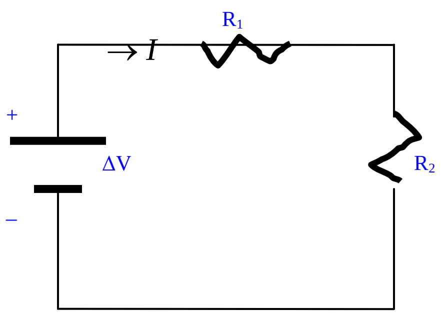
Lab 8: Capacitors and resistors in series and parallel,

Resistor boxes: decadic boxes;
capacitors: 10pF, 100pF, 1000pF, 0.01, 0.1 F; 100 and 200 µF
DMM, smart timers, new power supplies up to 18V.
Be careful, when measuring currents. Estimate your highest current value and then set the DMM accordingly. When in doubt, start with the highest mA settings on the DMM.

1) Resistors in parallel and series: Use 50, 100 Ohm resistors. Apply 15 Volts.
a) in series: Measure the voltage drop across individual resistors and the record the output voltage. Measure the current in the circuit. Put a DMM inline (in series) to measure the current. Use a second DMM to measure the voltage. Note that you expect a maximum current of around 15/50=300mA.
Verify that $\Delta V_{eq} = \Delta V_1 + \Delta V_2 = (R_1 + R_2) I$

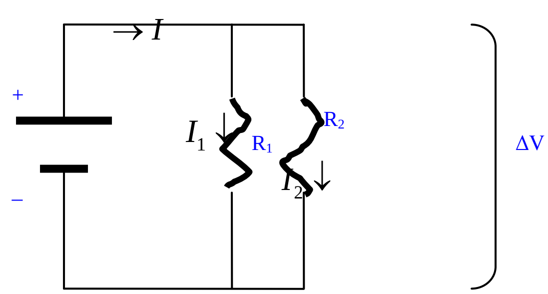


Measure the voltage drop across the equivalent resistor. Measure the current in the main loop with the DMM. Calculate $R_{equ} = \frac{\Delta V}{I}$ and compare with your theoretical calculation. Assume that the value on the resistor box is accurate.

b) in parallel:
Measure the output voltage. Measure the currents I, I_1 and I_2. Verify that

$$I_1 = I - I_2 \text{ and } I = \frac{\Delta V}{R_{eq}};\ I_2 = \frac{\Delta V}{R_2}; I_1 = \frac{\Delta V}{R_2}$$

Calculate the equivalent resistance and compare it to the measured result of the voltage drop



divided by the total current.

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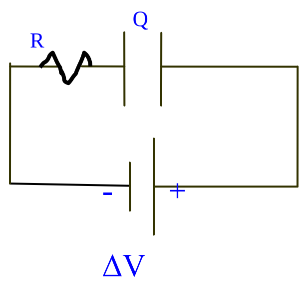
2) **Capacitors and resistors**:



Use a 0.01 Farad capacitor and a 200 Ohm resistor and set them up as above. Apply an exterior voltage of 12 volts (measure it). Calculate the maximum charge and the time constant.

Q_{max}=

RC=

Calculate how long does it takes to charge the capacitor to 90%:

Measure the voltage drop across the resistor in intervals of 3 s for approximately 20 values. Short the capacitor before starting your experiment. Test your setup before you take the actual measurements. Measure the resistor value.
Plot V versus t in Excel. Find the exponential trendline and the RC value. Calculate the percent error with your expected value for RC. Put equation and R^2 value on graph.
If your results are off be more than 6%, try the ln of your voltage to get a straight line. You can discard values (at the beginning or end of your measurement) which are not fitting. Check if this helps your results.

$$Q(t) = \varepsilon C(1 - e^{\frac{-t}{RC}})$$

$$I(t) = \frac{\varepsilon}{R} e^{\frac{-t}{RC}}$$

$$\Delta V = RI = \varepsilon e^{\frac{-t}{RC}}$$

Repeat the experiment but measure the current instead of the voltage drop.

Use Excel to plot I versus t. Find the exponential trendline and the RC value. Calculate the percent error with your expected value for RC. Put equation and R^2 value on graph.

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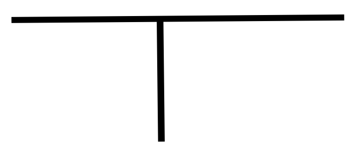
If your results are off be more than 6%, try the ln of your voltage to get a straight line. You can discard values (at the beginning or end of your measurement) which are not fitting. Check if this helps your results.

Triple junctions:

In some of the experiments you need to create triple junctions. You can do this with the wires



supplied: