Simple circuits

Identification page

Instructions: Print this page and the following ones before your lab session to prepare your lab report. Staple them together with your graphs at the end. If you forgot to print it before your lab, you can reproduce it by hand but you have to follow the exact format (same number of pages, same items on each page, same space to answer question).

Complete <u>all the identification fields below</u> or 10% of the lab value will be deduced from your final mark for this lab.

For in-lab reports, hand in your report to your demonstrator at the end of the sessions or you will receive a zero for this lab.

For take-home reports, drop your report in the right box or 10% of the lab value will be deduced from your mark. Refer to the *General information* document for the details of the late report policy.

Experiment title: Simple circuits ______________________

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Name: ______________________

Student number: ______________________

Lab group number: ______________________

Course code: PHY ______________________

Demonstrator: ______________________

Date of the lab session: ______________________

Partner's name: ______________________

Data sheet

Instructions: Use a pen to complete this section before the end of the lab session. Ask your TA to initial your data before you leave the laboratory.

Part 1 – Measuring a resistance value

[3] Complete the following table:

Table 1 - Resistance values

	Color code	Coded resistance value (Ω)	Coded tolerance (%)	Coded tolerance (Ω)	Measured resistance value (kΩ)	Measured absolute error ± (0.4% + 1 Ω) (kΩ)	Are both values within tolerance? (yes or no)
R_1	yellow-violet-brown-gold	470	5	23.5			
R_2	brown-black-red-gold						
R_3	orange-orange-red-gold						

Part 2 – Ohm's law

[2] Complete the following table (no need for uncertainties):

Table 2 – Voltage vs. current to verify Ohm's law

Suggested power supply voltage (V)	Measured voltage at the resistor (V)	Current going through the resistor (mA)
0.25		
0.50		
0.75		
1.00		
1.25		
1.50		
1.75		
2.00		

[4] Prepare Graph 1. **Print** it to a pdf file. Send the file to yourself by email or save it on a USB key. Print the graph and attach it at the end of your report.

[1] What are the values of m (slope) and b (Y-intercept) in Graph 1? Provide the units.

$m = (\_\_\_\_\_\_\_\_\_\_ \pm \_\_\_\_\_\_\_\_\_\_)$ $b = (\_\_\_\_\_\_\_\_\_\_ \pm \_\_\_\_\_\_\_\_\_\_)$

Part 3 – Combination of resistors

[2] Using the ohmmeter, fill the following table (no need for uncertainties):

Table 3 - Effective resistance for resistors in series

Resistors in series	Measured resistance value (kΩ)
$R_1 - R_2$	
$R_1 - R_3$	
$R_2 - R_3$	
$R_1 - R_2 - R_3$	

[2] Using the ohmmeter, fill the following table (no need for uncertainties):

Table 4 - Effective resistance for resistors in parallel

Resistors in parallel	Measured resistance value (kΩ)
$R_1//R_2$	
$R_1//R_3$	
$R_2//R_3$	
$R_1//R_2// R_3$	

[1] Using the ohmmeter, what is the effective resistance value of the mixed circuit $R_1 - (R_2// R_3)$.
Use an uncertainty of ± (0.4% + 1 Ω).

$R_{\text{effective}} = (\_\_\_\_\_\_\_\_\_\_ \pm \_\_\_\_\_\_\_\_\_\_)$

Part 4 – Voltages and currents in circuits (Kirchhoff's rules)

[3] Measure the voltage drops and the currents at each resistor in the mixed circuit. Provide the units.

$\Delta V_0 = (\_\_\_\_\_\_\_\_\_\_ \pm \_\_\_\_\_\_\_\_\_\_)$ $I_1 = (\_\_\_\_\_\_\_\_\_\_ \pm \_\_\_\_\_\_\_\_\_\_)$

$\Delta V_1 = (\_\_\_\_\_\_\_\_\_\_ \pm \_\_\_\_\_\_\_\_\_\_)$ $I_2 = (\_\_\_\_\_\_\_\_\_\_ \pm \_\_\_\_\_\_\_\_\_\_)$

$\Delta V_{2//3} = (\_\_\_\_\_\_\_\_\_\_ \pm \_\_\_\_\_\_\_\_\_\_)$ $I_3 = (\_\_\_\_\_\_\_\_\_\_ \pm \_\_\_\_\_\_\_\_\_\_)$

The uncertainty readings for ΔV are $\pm(0.3\% + 0.001\text{ V})$ and I are $\pm(1\% \pm 0.02\text{ mA})$.

Part 5 – Combinations of capacitors & RC circuits

[2] Using the Fluke multimeter, fill the following table (no need for uncertainties):

Table 5 - Effective capacitances for capacitors in series and in parallel

Capacitors	Measured capacitance value (nF)
C_1	
C_2	
$C_1 - C_2$ (in series)	
$C_1 // C_2$ (in parallel)	

[2] What is the value of the parameter *C* in the exponential fit (*A**exp(-*Ct*) + *B*) of the discharging capacitor? Provide the units and uncertainty.

parameter C = (______________ ± ______________)

Note: The parameter *C* here is a fitting parameter for your exponential equation. Do not confuse it with the variable *C* used in eq. 5 which corresponds to the capacitance in your RC circuit.

Questions

Instructions: You can finish this section at home. We encourage you to start answering these questions while you are still in the lab and the TA is available to help you.

Part 1 – Measuring a resistance value

[2] Give a sample calculation for the measured absolute error for R_2.

[2] How did you determine if the coded and measured values of a resistor were within tolerance of each other?

Part 2 – Ohm's law

[1] What is the physical meaning of the slope in Graph 1? Did you get the expected value?

Part 3 – Combination of resistors

[2] Your data from *Table 3* should show that the rule for combining resistors in series is simple:

$$R_{eff} = R_1 + R_2 + \cdots$$

Based on your data from *Table 4*, what is the apparent rule (or equation) for combining resistors in **parallel**?

Verify that the rule is valid for $R_2//R_3$ by using your R values from *Table 1* for the calculation and compare with your measured value from *Table 4*. **No error calculation needed.**

[1] Using your value for R_1 from *Table 1* and the result of the previous question, calculate the effective resistance value of the mixed circuit $R_1 - (R_2// R_3)$. Does your measured value correspond to your calculated value for the effective resistance? **No error calculation needed.**

Part 4 – Voltages and currents in circuits (Kirchhoff's rules)

[3] Based on your measurements for current, apply the junction rule in your circuit at node *c*. Is the junction rule valid? (Hint: see eq. 2). **You must show the error calculation for eq. 2.**

[3] Based on your measurements for $\Delta V_{2//3}$ and I_2, verify whether the Ohm's law equation (see eq. 1) is valid for R_2 in the mixed circuit. **You must show the error calculation for R_2.**

[2] Based on your measurements for current and your data from *Table 1*, apply the loop rule in your circuit for the small loop that passes through R_2 and R_3 (see eq. 4). Is the loop rule valid? **No error calculation needed.**

Part 5 – Combinations of capacitors & RC circuits

[2] Based on your data from *Table 5*, what are the apparent rules (or equations) for combining capacitors in **series** and **parallel**? How do these differ from the rules for resistors?

[3] Using your measurement for R_2 (see *Table 1*) and your fitting parameter *C* mentioned above, calculate the capacitance of your capacitor (use eqn. 5). Note that $1\ \mathrm{F} = 1\ \mathrm{s}/\Omega$. Compare your result to the value measured using the multimeter. **No error calculation needed.**

Total: ___ / 43
(Total including graph)