PHYS 102 EXPERIMENT 1. ELECTRICAL MEASUREMENTS

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Data & Results: [25]

Voltage (V)	5.0	8.0	11.0	14.0	17.0	20.0
Current (A)	0.034	0.054	0.075	0.094	0.115	0.137

Table 1: Current-voltage relation across the resistor 1

$V=IR \Rightarrow R_{11}=\frac{5}{0.034}=147.06$, $R_{12}=\frac{8}{0.054}=148.15$, $R_{13}=\frac{11}{0.075}=146.67$

$R_{14}=\frac{14}{0.094}=148.94$, $R_{15}=\frac{17}{0.115}=147.83$, $R_{16}=\frac{20}{0.137}=145.99$

Measured $R1=\frac{R_{11}+R_{12}+R_{13}+R_{14}+R_{15}+R_{16}}{6}=147.44\,\Omega$

This method much safer to found R1 than finding with only last and first values.

$R1 = 150\,\Omega$	$\frac{\Delta R1}{R1}=\frac{150-147.44}{150}=0.017$

Percentage error $= 0.017\times100 = 1.7\%$

absolute error $= \Delta R1 = 2.56\,\Omega$

Voltage (V)	5.0	8.0	11.0	14.0	17.0	20.0
Current (A)	0.034	0.053	0.074	0.093	0.115	0.136

Table 2: Current-voltage relation across the resistor 2

$V=IR \Rightarrow R_{21}=\frac{5}{0.034}=147.06$, $R_{22}=\frac{8}{0.053}=150.94$, $R_{23}=\frac{11}{0.074}=148.65$

$R_{24}=\frac{14}{0.093}=150.54$, $R_{25}=\frac{17}{0.115}=147.83$, $R_{26}=\frac{20}{0.136}=147.06$

Measured $R2=\frac{R_{21}+R_{22}+R_{23}+R_{24}+R_{25}+R_{26}}{6}=148.68\,\Omega$

$R2 = 150\,\Omega$	$\frac{\Delta R2}{R2}=\frac{150-148.68}{150}=0.009$

Percentage error $= 0.009\times100 = 0.9\%$

absolute error $= 1.32\,\Omega$

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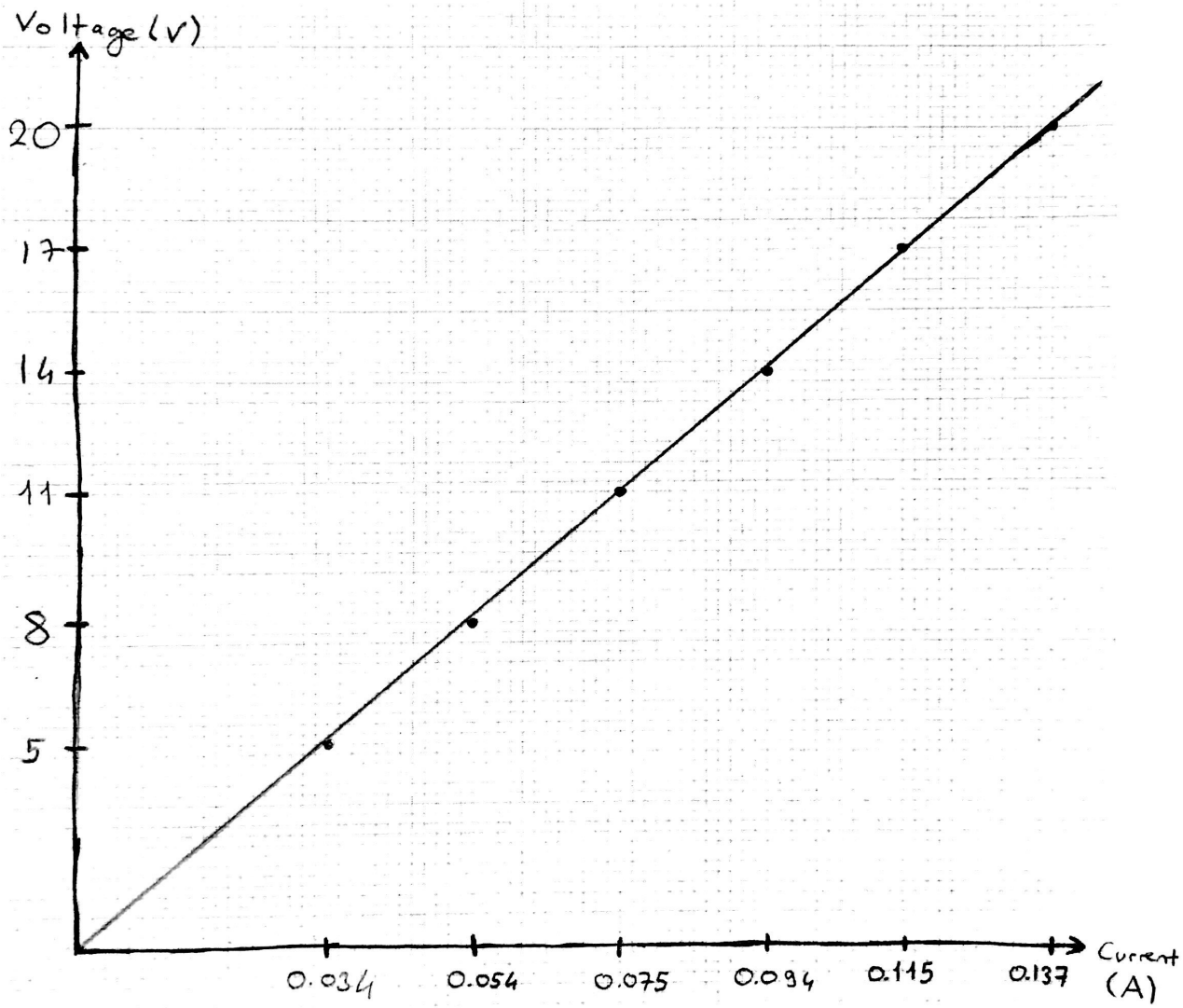
Plot 1 [15]:

I - V (Current - Voltage) Characteristics of Resistor 1



→ is best line since it pass all the points nearly at least, and it connects origin with other points which must be starting point (0V = 0A)

Uncertainties due to measurement device :
For voltage it was 0.1. (The above values actually 5.0, 8.0, so on)
For current it was 0.001
it is better to draw worst lines with these values but our TA must ask us to draw best line.

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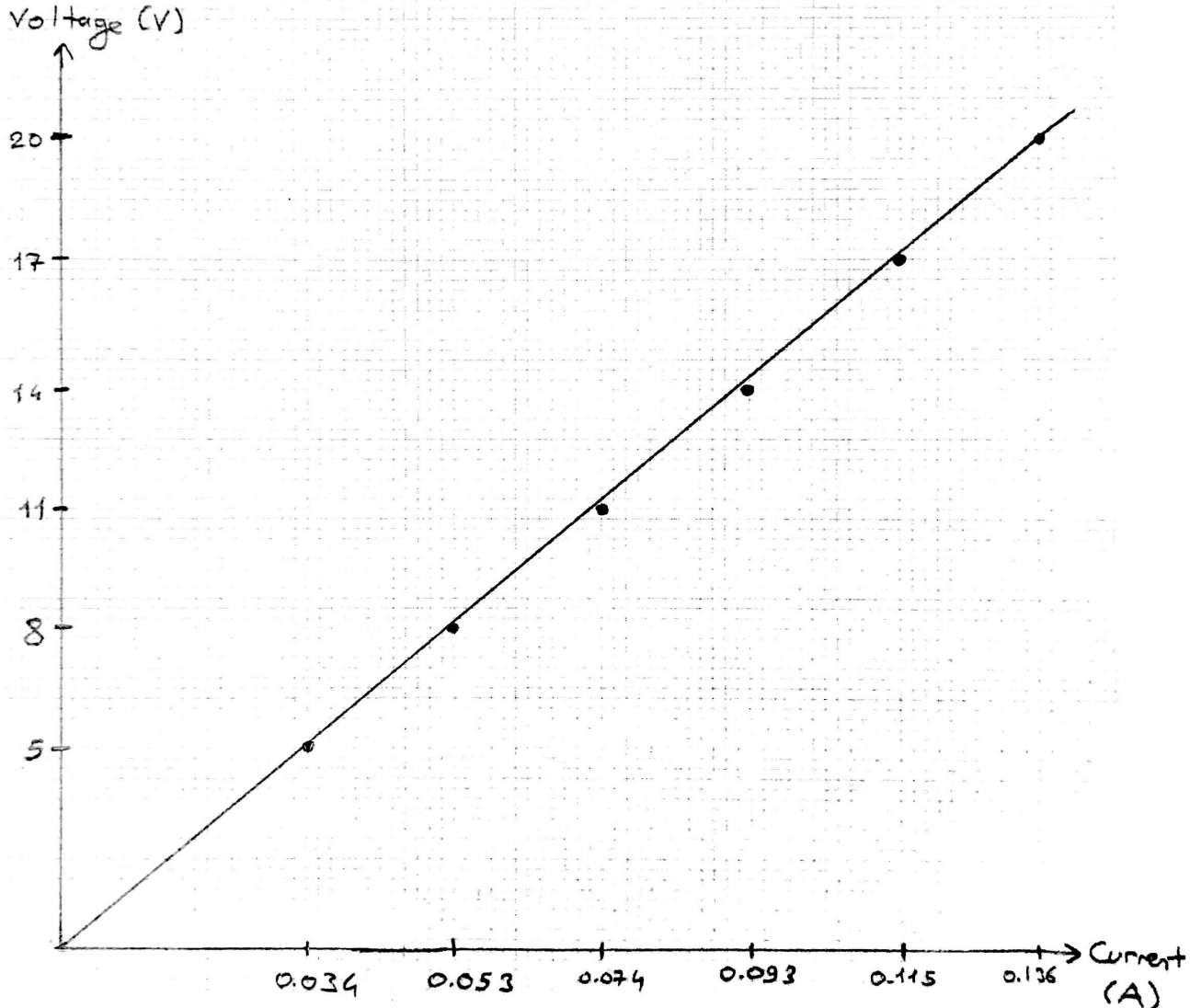
Plot 2 [15]:

I-V (Current-Voltage) Characteristics of Resistor 2



— → is best line due to previous reasons.

Uncertainties due to measurement device:

Voltage → $\Delta V = 0.1$

current → $\Delta A = 0.001$

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Conclusion: [15]

This experiment was aimed to introduce basic circuit elements, understand basic electrical measurements and relationship between them. Particularly the relationship between current-voltage pair and resistor value was considered. This was achieved by using the ohm's Law. [V = I.R (V: Voltage (V), I: Current (A), R: Resistance (Ω))].

We were given 2 identical resistors that have resistance value 150Ω. we did 6 measurements for each resistor by changing voltage value from 5 to 20 Volts incremented with 3 volts in each step. By collecting current values for each measurement, we drew 2 graphs one for each resistor. Then we drew the best lines and saw that Ohm's Law is experimentally correct since best lines are linear.

From measurements, we calculated resistors experimental values. I calculate each measurements separately and found resistors values by dividing them to the number of measurements (since the graphs in back pages, I think we should not use best lines to calculate it.). It turns out that R1 = 147.44Ω with 1.7% error and R2 = 148.68Ω with 0.9% error. There is 2 types of errors here. First one is due to measurement The measurement device had 0.1 ΔV uncertainty and 0.001 ΔA uncertainty which can affect the result significantly. Also the cables, in real life, not absolutely "without resistance". Second type of errors is 150Ω resistor is not exactly 150Ω. Its value can be changed with time and temperature and humidity and lots of other effects. Therefore, manufacturers define tolerance that the bound values of the resistors. It is generally be 150±10Ω and I believe it is the case for us. Since we did the 2 experiments (humidity, temp. dif. eliminated) in same environment resistor values are very close.

In conclusion, I learned Ohm's Law and some possible error sources, as well as not all the resistors are same. Also not to touch the resistor in series. (Too hot :))