**General Physics Laboratorium**

Laboratorium #3

Topic: 100 B „Measurement of resistance”

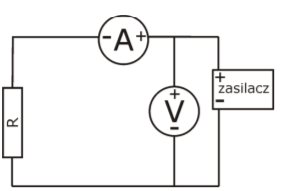
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| Name, Surname | Nykonchuk Illia, 245693, W08 |
| Time of classes: | Tuesday, 17:05-18:45 |
| Number of group : | Z00-33d |
| Date of submit: | 02.04.2020 |
| **Grade:** |  |

Approving the measurement results.

Date and signature of the lecturer **............................................................**

Introduction

The laboratory was done to familiarize with basic electrical measurements and to reduce the dependence of the electric current through the resistor and light bulb on the applied voltage. First what was made is measuring of the resistance, then the voltage and current when the voltage on the power supply was changed.

Steps

Assembly of the electrical system in accordance with the circuit shown in picture

1. Resistance measurements for different Voltage values
2. Calculation of resistance based on previously obtained measurement results using Ohm's law
3. Calculation of measurement uncertainty and compilation of resistance diagrams
4. Calculation of Linear Regression and comparing with direct measurements
5. Plotting graphs I(U)

Formulas

All the measurements were performed with a DT-890G multimeter, on the following ranges and with following uncertainties

200 Ω – 0.8% rdg (measured value) + 3 dgt (last displayed figure, 0.1 Ω; 0.1 mA; 0.01 V)

or 2000 Ω – 0.8% rdg + 1 dgt

200 mA – 1.2% rdg + 1 dgt

20 V – 0.5% rdg + 1 dgt

Therefore,

**Meter uncertainty:** Ω

* Rdg – reading (value read)
* Dgt – digit (value of last figure)

Other uncertainty values were calculated according to the same formulas, with the voltage measuring range being 20V and the measuring current 200mA

**Resistance:**  Ω

Coefficients a and b (and their uncertainties) of the equation I=aU+b were determined by linear regression using LINEST Excel function.

Results of measurements

Results of direct measurements with ohmmeter:

Light bulb RB=24.7 Ω

Resistor RR=240.2 Ω

Resistor

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Bias (V) | Current (mA) | u(I) [mA] | Voltage (V) | u(U) [V] |
| 3.0 | 13.4 | 0.26 | 3.28 | 0.17 |
| 4.5 | 19.4 | 0.33 | 4.74 | 0.25 |
| 6.0 | 25.9 | 0.41 | 6.30 | 0.33 |
| 7.5 | 32.2 | 0.49 | 7.81 | 0.40 |
| 9.0 | 39.1 | 0.57 | 9.48 | 0.48 |
| 12 | 50.8 | 0.70 | 12.27 | 0.62 |

Light bulb

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Bias (V) | Current (mA) | u(I) [mA] | Voltage (V) | U(V) [V] |
| 3.0 | 14.9 | 0.28 | 3.28 | 0.17 |
| 4.5 | 18.6 | 0.32 | 4.74 | 0.25 |
| 6.0 | 22.1 | 0.37 | 6.30 | 0.33 |
| 7.5 | 25.2 | 0.40 | 7.81 | 0.40 |
| 9.0 | 28.1 | 0.44 | 9.48 | 0.48 |
| 12 | 32.7 | 0.49 | 12.26 | 0.62 |

Calculations

Resistor Resistance: u(R) = +-(0.8%\*240.2+0.1) = +-2.0216 ≈ +-2.1 Ω

Light Bulb Resistance: u(R) = +-(0.8%\*24.7+3\*0.1) = +-0.23≈0.3

Example of calculating uncertainties for Light bulb with current = 3V:

Results of calculations are presented in table above

Linear Regression for Resistor: I=aU+b

I = 4.16\*U - 0.3 mA

Uncertainty of a = 0.01 mA/V

Uncertainty of b = 0.05 mA

b is bigger than u(b), but it is still small, so we can calculate Resistance which is - practically the same result as for ohmmeter

Linear Regression for Light bulb: I=aU+b  
 I = 1.97\*U + 9.20 mA

Uncertainty of a = 0.09 mA/V

Uncertainty of b = 0.7 mA

In that case, b is much larger than u(b), so by regression - different result from ohmmeter. This is due to the fact, that we can’t calculate Resistance for light bulb because it increases with temperature, so we should use formula of power to calculate it properly (P=U\*I)

Plots

Resistor Regression results

|  |  |  |
| --- | --- | --- |
| Bias (V) | Current (mA) | Voltage (V) |
| 3.0 | 13.34 | 3.28 |
| 4.5 | 19.42 | 4.74 |
| 6.0 | 25.9 | 6.30 |
| 7.5 | 32.2 | 7.81 |
| 9.0 | 39.1 | 9.48 |
| 12 | 50.7 | 12.27 |

I = 4.16\*U - 0.3 mA

Light bulb Regression results

|  |  |  |
| --- | --- | --- |
| Bias (V) | Current (mA) | Voltage (V) |
| 3.0 | 15.6 | 3.28 |
| 4.5 | 18.5 | 4.74 |
| 6.0 | 21.6 | 6.30 |
| 7.5 | 24.6 | 7.81 |
| 9.0 | 27.9 | 9.48 |
| 12 | 33.4 | 12.26 |

I= 1.97\*U + 9.20 mA

Final results

Resistor

|  |  |  |  |
| --- | --- | --- | --- |
| Bias (V) | Current (mA) | Voltage (V) | Resistance(Ω) |
| 3.0 | 13.4± 0.26 | 3.28± 0.17 | 240.2±19.3 |
| 4.5 | 19.4± 0.33 | 4.74 ± 0.25 |
| 6.0 | 25.9± 0.41 | 6.30± 0.33 |
| 7.5 | 32.2± 0.49 | 7.81± 0.40 |
| 9.0 | 39.1± 0.57 | 9.48± 0.48 |
| 12 | 50.8± 0.70 | 12.27± 0.62 |

I = 4.16\*U - 0.3 mA

Light bulb

|  |  |  |  |
| --- | --- | --- | --- |
| Bias (V) | Current (mA) | Voltage (V) | Resistance(Ω) |
| 3.0 | 14.9±0.28 | 3.28±0.17 | 24.7± 2.3 |
| 4.5 | 18.6±0.32 | 4.74±0.25 |
| 6.0 | 22.1±0.37 | 6.30±0.33 |
| 7.5 | 25.2±0.40 | 7.81±0.40 |
| 9.0 | 28.1±0.44 | 9.48±0.48 |
| 12 | 32.7±0.49 | 12.26±0.62 |

I = 1.97\*U + 9.20 mA Conclusion

Based on the above calculations, it can be concluded that the uncertainties of the measured values ​​are small compared with the measured values. They are small because they consider only the accuracy of the meter, which is well known and prone to a slight error. The results of measurements with an ohmmeter were compared with the results of linear regressions (I = 4.16 \* U - 0.3 mA for the resistor and I = 1.97 \* U + 9.20 mA for the bulb), and there was no significant difference, for except for the fact that the bulb does not obey Ohm's law, while the resistor obeys. Thus, we can conclude that the resistance may depend on temperature. That’s why we got a huge difference in measuring resistance with an ohmmeter (240.2 Ohms) and linear regression (507.6 Ohms). Other causes of uncertainty, such as the uncertainty of the experimenter were not considered, because we reject the possibility of incorrect measurement or reading. In the graph of I = f (U) and linear regression, the regression line passes through the measurement points, which also indicates a small measurement error.