OPPA European Social Fund
Prague & EU: We invest in your future.

CZECH TECHNICAL UNIVERZITY IN PRAGUE	DEPARTMENT OF PHYSICS			
LABORATORIES FROM PHYSICS				
Name				Date of measurement
Year of study	2	Term	2010/2011	Date of commitment
Stud. group	101	Lab. group		Classification
Task's number	Task's name			
3	**Determination of temperature coefficient of resistance of metals**			

Task 3

Determination of temperature coefficient of resistance of metals

3.1 Measurement task

1. Measure the temperature coefficient of resistance of copper in range 20 – 80 °C.
2. Measure the temperature coefficient of resistance of platinum in range 20 – 80 °C.
3. Make a graph of dependence of resistance R on the temperature *t* for the both materials.
4. Determine the calculation error for the temperature coefficient of resistance of metals.

3.2 Procedure and method of measurement

1. Connect the equipment due to picture. The measurement of resistance we do on measuring Wheatstone bridge MLG-Metra.

2. Fill the beaker with 650 g of water, put the stirring inside and measure the resistance.

3. Put the beaker on the hot plate of mixer and insert the thermometer with distance around 50 mm over the bottom. Join the mixer to electrical network.

4. Turn the miser on and set the number of the turns to 300 ot./min.

5. After 5 minutes turn on the mixer's heater and measure the resistance of the sample approximately after 2°C in range of 20 - 80 °C. We calculate the measured values by the method of least squares so it isn't necessary to measure the resistance in dependency on the temperature equidistant. So due to this we measure the resistance after 2 °C other ways we set the bridge and after than we take off the value of resistance. Also is necessary to balancing the bridge for the whole time of measurement.

6. The measured values process by the method of least squares and calculate the probable error.

3.3 The list of used tools

Magnetic mixer
Product of copper conductor
Product of platinum conductor
Beaker
Wheatstone bridge

3.4 The table of measured values, processing of the results

	Copper	Platinum		Copper	Platinum
t [° C]	R [Ω]	R [Ω]	t [° C]	R [Ω]	R [Ω]
28	106,0	111,0	46	111,9	117,6
30	106,8	111,6	48	112,6	118,6
32	107,0	112,4	50	113,3	119,2
34	108,0	113,2	52	113,7	119,9
36	108,6	114,0	54	114,3	120,9
38	109,3	114,8	56	114,9	121,5
40	110,1	115,4	58	115,6	122,2
42	110,8	115,9	60	116,1	122,9
44	111,5	117,1			

Table of measured values for copper and platinum.

By the method of the least squares we calculate a,b from the equation $y = ax + b$. The equations for them are:

$$a = \frac{\sum_{i=1}^{n}(x_i - \bar{x})y_i}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad , \quad b = \bar{y} - a\bar{x} .$$

For copper:

a = 0,307924498
b = 97,7050118

For platinum:

a = 0,377121471
b = 100,3577414

Now we calculate α

$$\alpha = \frac{a}{b}$$

For copper is α = 3,151573*10^{-3}, and for platinum is α = 3,757772*10^{-3}

We also have to calculate the standard deviation of regression point which we calculate by the equations

$$s_a = \frac{s}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}} \quad , \quad s_b = s\sqrt{\frac{1}{n} + \frac{\bar{x}^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2}} \quad , \text{ where}$$

$$s = \sqrt{\frac{1}{n-2}\left(\sum_{i=1}^{n} y_i^2 - b\sum_{i=1}^{n} y_i - a\sum_{i=1}^{n} x_i y_i\right)}$$

For copper:

s_a = 0.006384006
s_b = 0.281801634

For platinum:

s_a = 0.002584139
s_b = 0.114068587

As next we calculate uncertainties of regression parameters by the equation:

$$\vartheta_{a,b} = \frac{2}{3} s_{a,b}$$

For copper:

ϑ_a = 0.004256004

ϑ_b = 0.187867756

For platinum:

ϑ_a = 0.001722759

ϑ_b = 0.076045725

And finally we calculate the complete uncertainties of drag coefficient by the equation

$$\vartheta_\alpha = \frac{1}{b^2}\sqrt{b^2 \vartheta_a^{\,2} + a^2 \vartheta_b^{\,2}}$$

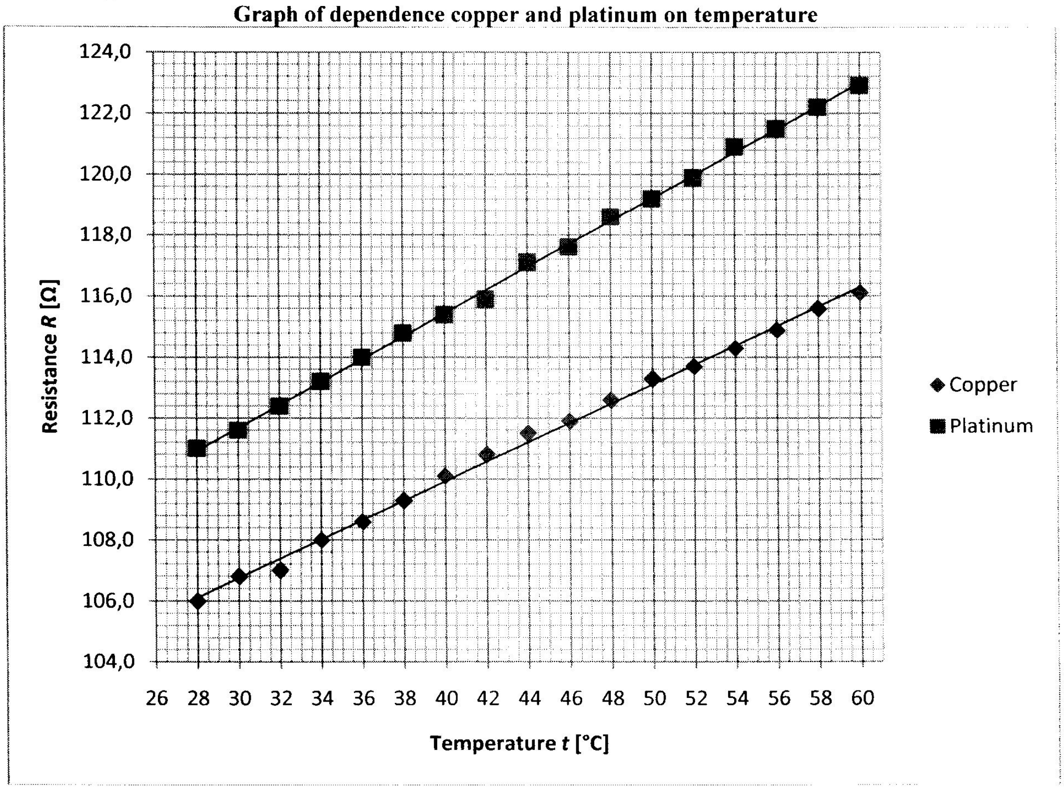
For copper:

ϑ_α = 0,0000439792

For platinum:

ϑ_α = 0,0000174007

3.5 Graphs



3.6 Conclusion and results

The temperature coefficient of resistance of copper is (3,15 ± 0,43)*10^{-3}. K^{-1}
The table value is $\alpha_{Cu} = 4{,}33 \cdot 10^{-3}$ K^{-1}.

The deviation from the table value is 27,25%

The temperature coefficient of resistance of platinum is (3,76 ± 0,17)*10^{-3} K^{-1}
The table value is $\alpha_{Pt} = 3{,}92 \cdot 10^{-3}$ K^{-1}.

The deviation from the table value is 4,18%

For the temperature dependence of copper's and platinum's resistance we used the method of least squares for the measured values. By this method we determined the temperature coefficient of resistance of metals α and probable errors of these values. We also made a graph of the dependence of resistance *R* on the temperature *t* for the both of the materials and we approximated the measured points by the line. This graph is linear with the little deviations of some points. This is caused by the measurement uncertainty of resistance *R*. The measurement was also affected by the sensitivity and accuracy of galvanometer and the accuracy of the bridge.

OPPA European Social Fund
Prague & EU: We invest in your future.
