CZECH TECHNICAL UNIVERSITY IN PRAGUE	DEPARTMENT OF PHYSICS		

LABORATORIES FROM PHYSICS

Name			Date of measurement **4.4.2017**
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Stud. group **102**	Lab. group **9**		Classification

Task's number	Task's name
L1	**Acceleration due to gravity measurement**

Task L1

Acceleration due to gravity measurement

4.1 Measurement task

1) To measure acceleration due to gravity for Prague.
2) To plot a graph of the dependence of τ_{0d} and τ_{0u} on the lens position.
3) To evaluate combined uncertainty of the measurement.

4.2 The list of used apparatus

- Reversion pendulum with lens and three-side prism
- Electric swing counter with stopwatch
- Metre (to measure distance L)

4.3 Measured values

Distance L between two blades on pendulum:

$L = 0{,}598 \pm 0{,}001$ m

Table of measured values:

Shift of lens on pendulum [mm]	Position of pendulum	
	Bottom	Upper
	$100\times\tau_{0b}$ [s]	$100\times\tau_{0u}$ [s]
0	77,10	76,02
1	77,15	76,24
2	77,21	76,55
3	77,26	76,73
4	77,32	76,94
5	77,36	77,21
6	77,42	77,44

In case of 6 mm shift we got almost the same values both for bottom and upper position. That's why we measure 500 oscillation for this position.

Shift of lens on pendulum [mm]	Position of pendulum	
	Bottom	Upper
	$500\times\tau_{0b}$ [s]	$500\times\tau_{0u}$ [s]
6	387,06	386,87
τ	0,77412	0,77374

4.4 Computations

Average time $\bar{\tau_0}$ for one oscillation.

- τ_{0b} = time of one oscillation in bottom position.
- τ_{0u} = time of one oscillation in upper position.

$$\bar{\tau_0} = \frac{\tau_{0b} + \tau_{0u}}{2} = 0{,}77393\ [s]$$

Combined uncertainty of one oscillation period time:

Uncertainty of determination of osciallation time τ_0:

$$u_M(\tau_0) = \sqrt{\frac{(\tau_{0b} - \bar{\tau_0})^2 + (\tau_{0u} - \bar{\tau_0})^2}{2}} = 0{,}00019\ [s]$$

Uncertainty of stopwatch:

$$u_{SW}(\tau_0) = \frac{\frac{0{,}01}{500}}{\sqrt{3}} = 0{,}00001154\ [s]$$

So the combined uncertainty of one oscillation period time:

$$u_c(\tau_0) = \sqrt{(u_M(\tau_0))^2 + (u_{SW}(\tau_0))^2} = 0{,}00019035\ [s]$$

Uncertainty of distance between two blades on reverse pendulum:

$$u(L) = \frac{0{,}001}{\sqrt{3}} = 0{,}000577\ [m]$$

Acceleration due to gravity - unccorected value:

$$g = \frac{\pi^2 L}{\tau_0^2} = 9{,}85366\ [m \cdot s^{-2}]$$

$$u_c(g) = \sqrt{\left(\frac{\pi^2}{{\tau_0}^2} u(L)\right)^2 + \left(\frac{2\pi^2 L}{{\tau_0}^3} u_c(\tau_0)\right)^2} = 0{,}0106719\ [m \cdot s^{-2}]$$

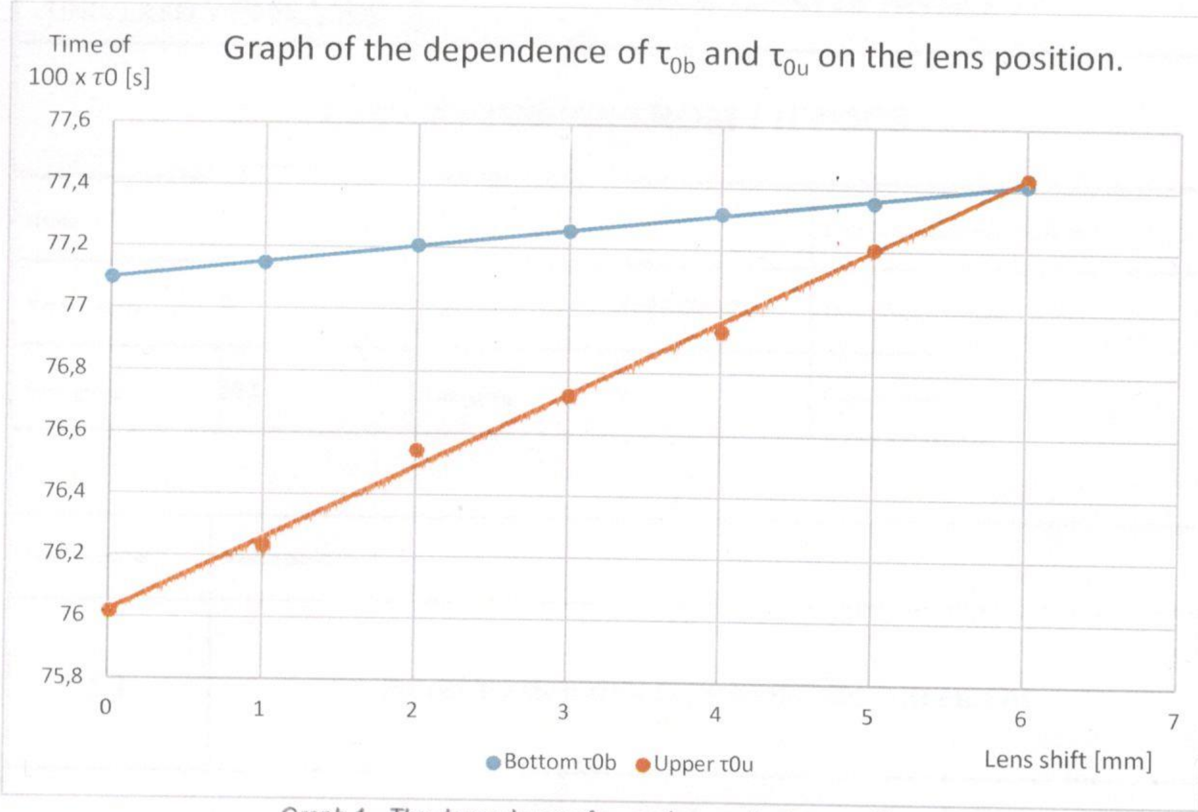
Acceleration due to gravity – corrected value:

$$\tau_{0c} \cong \frac{\tau_0}{1 + {}^1\!/_4 \sin^2 \frac{\varphi}{2}} = 0{,}7736\ [s] \qquad (\text{for } \varphi = 5°)$$

$$g_c = \frac{\pi^2 L}{{\tau_{0c}}^2} = 9{,}86207\ [m \cdot s^{-2}]$$

$$u_c(g_c) = \sqrt{\left(\frac{\pi^2}{{\tau_{0c}}^2} u(L)\right)^2 + \left(\frac{2\pi^2 L}{{\tau_{0c}}^3} u_c(\tau_0)\right)^2} = 0{,}0106819\ [m \cdot s^{-2}]$$

4.5 Graphs



Graph 1 - The dependence of τ_{0b} and τ_{0u} on the lens position.

4.6 Results and conclusions

In this task we learned, to measure acceleration due to gravity. In our case for Prague. In next step we measured the possible uncertainties.

Acceleration due to gravity for Prague (Prague 6, Technická 2, 4th floor)**:**

- for uncorrected time of oscillation $g = 9{,}85 \pm 0.01\ [m \cdot s^{-2}]$
- for corrected time of oscillation $g_c = 9{,}86 \pm 0.01\ [m \cdot s^{-2}]$

Final uncertainties of our measurement are equal to the same value:

$$u_c(g) = u_c(g_c) = 0.01\ [m \cdot s^{-2}]$$

Table value of acceleration due to gravity for Prague is:

$$g = 9{,}81373\ [m \cdot s^{-2}]$$