Physical Pendulum

A *physical pendulum* is any hanging object which oscillates about a fixed axis under the effect of gravity. Its period only differs from that of a mathematical pendulum by a constant factor determined by the mass distribution.

Goal: You compare your measurements to the theoretical prediction. The main focus of this lab is (once again) the analysis with a spreadsheet program.

Setup:

- Stand with low-friction axle
- Different plates and rods
- Stopwatch and meter stick

Procedure:

A Choose one of the plates. Measure the distance of the different holes to the centre of mass.

B Let the plate oscillate about an axis through one of the holes. Measure the period at very small amplitude. Choose a number of oscillations which allows you to measure the period with a precision of at least 1 %. Repeat the measurement for the other holes.

C Measure the period of the oscillating rod for some fifteen different holes.

Analysis

1. Using the general formula in "Formeln und Tafeln" (pp 147f), derive a formal expression for the period of the plate's oscillation. Calculate the theoretical periods for the different holes and display them in a nicely formatted table (with errors). Check whether the calculated values are compatible with the theoretical ones.
2. Plot the (measured) period vs. the distance of the hole from the centre of mass. Add the theoretical graph to the diagram.
3. Find a formal expression for the distance where the period reaches a minimum. Calculate the numerical values for this distance and the minimum period.
4. Analyse the data for the rod in an analogous way.
5. Show that for the rod the relation

$$x \left(\frac{T}{T_0} \right)^2 = \frac{1}{12} + x^2$$

   holds true, where $x = s/L$ is the ratio of the distance s between the hole and the centre of mass and the length L of the rod, and T_0 is the period of a mathematical pendulum with the same length as the rod.
6. Use the relation in step 5 of the interpretation to draw a diagram in which the measured values should lie on a straight line. Fit a linear trend line into the data and compare the fit parameters to the theoretical prediction.

Requirements: If you do not write a report on this experiment, work at least on steps 1 and 2 of the analysis. The complete interpretation is required for a report.

Hand in your report or interpretation and the lab journal by Friday, 17 December 2010.