Mechanics

Oscillations

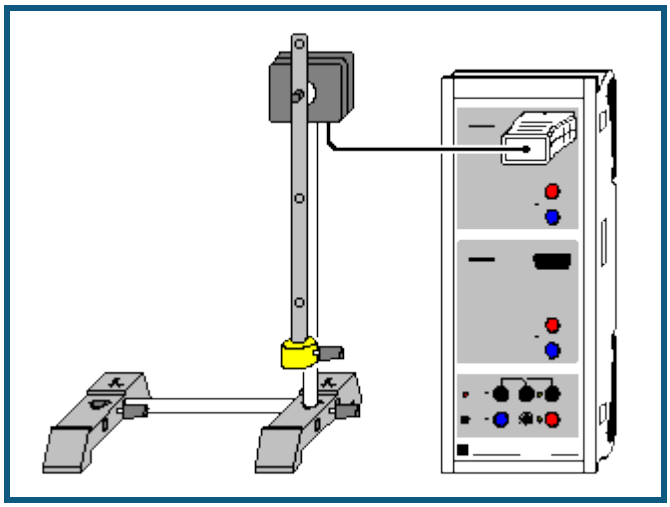
Simple and compound pendulum

Dependency of period of the oscillation of a rod pendulum on the amplitude

Description from CASSY Lab 2

For loading examples and settings, please use the CASSY Lab 2 help.

Dependency of the period of the oscillation on the amplitude



can also be carried out with Pocket-CASSY

Experiment description

The period T depending on the amplitude of the oscillation is recorded. For this the pendulum is activated once at the beginning and the amplitude and period are continuously recorded. Because of the low degree of friction, the amplitude reduces slowly. This in turn results in a small reduction in the oscillation period.

The equation of motion for a physical pendulum with moment of inertia J, mass m and distance s between fulcrum and center of gravity

$M = J \cdot \alpha'' = -m \cdot g \cdot s \cdot \sin \alpha$

describes for small deflections ($\sin \alpha \approx \alpha$) an harmonic oscillation with the period

$T = 2\pi \cdot \mathrm{sqrt}(l_r/g)$,

with the reduced pendulum length being $l_r = J/ms$. Without this approximation, in general the following applies

$T = 2\pi \cdot \mathrm{sqrt}(l_r/g) \cdot (1 + (1/2)^2 \cdot (\sin(\alpha/2)^2 + (3/4)^2 \cdot (\sin(\alpha/2)^4 + (5/6)^2 \cdot (\sin(\alpha/2)^6 + \ldots))))$.

Equipment list

1	Sensor-CASSY	524 010 or 524 013
1	CASSY Lab 2	524 220
1	Rotary motion sensor S	524 082
1	Physical pendulum	346 20
1	Stand rod, 25 cm, d = 10 mm	301 26
2	Stand bases MF	301 21
1	PC with Windows XP/Vista/7/8	

Experiment setup (see drawing)

The pendulum is screwed on the axle of the rotary motion sensor and the weight is attached to the lower end of the pendulum.

Carrying out the experiment

- Load settings
- Deflect the pendulum by approximately 30° and release
- Once the displayed value for the oscillation period T_{A1} has settled to a constant value, start the measurement by pressing
- If after a while no measuring points appear, click on the y-axis with the right mouse button and select **Find Minimum and Maximum**.
- Stop the measurement by clicking as soon as the amplitude falls below 5°. Below this the determined oscillation period will become unreliable.

Evaluation

During the measurement, the amplitude decreases slowly. This causes a minor reduction in oscillation period. The theoretical connection between amplitude and period is

$T = T_0 \cdot (1 + (1/2)^2 \cdot (\sin(\alpha/2)^2 + (3/4)^2 \cdot (\sin(\alpha/2)^4 + (5/6)^2 \cdot (\sin(\alpha/2)^6 + \ldots))))$

and can be easily confirmed by carrying out a free fit.