Physical pendulum (Item No.: P1254600)

Curricular Relevance

Area of Expertise: Physik
Education Level: Klasse 10-13
Topic: Mechanik
Subtopic: Schwingungen und Wellen
Experiment: Physikalisches Pendel (Reversionspendel)

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	10 Minutes	1 Student

Additional Requirements:

- Stopwatch

Experiment Variations:

Keywords:

Principle and equipment

Principle

Investigate the properties of physical pendulum.

Equipment

Position No.	Material	Order No.	Quantity
1	Demo Physics board with stand	02150-00	1
2	Clamp on fixing magnet	02151-01	1
3	Rod on fixing magnet	02151-02	1
4	Hook on fixing magnet	02151-03	1
5	Scale for demonstration board	02153-00	1
6	Weight holder for slotted weights	02204-00	1
7	Slotted weight, silver bronze, 10 g	02205-02	1
8	Slotted weight, silver bronze, 50 g	02206-02	1
9	Holding pin	03949-00	1
10	Lever	03960-00	1
11	Fish line, l. 100m	02090-00	1
12	Marker, black	46402-01	1
Additional material:			
13	Stopwatch		

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Set-up and procedure

Set-up

Procedure

Observation and evaluation

Observation

Evaluation

Evaluation 1

The oscillation period of the pendulum has the same value $T = 1.1s$ in each case, when it oscillates around the points A on the left, C on the left, or C on the right.

The lever which is used as a pendulum has a regular shape. Its mass is uniformly distributed over its length. For this reason, the result $T_{Cleft} = T_{Cright}$ could have been expected from the very beginning.

The fact that $T_{Aleft} = T_{Cright}$ is also true means that there are two points on the physical pendulum around which the pendulum can oscillate with the same oscillation period. The distance between these two points is termed the reduced pendulum length l_r and for the lever being used as a physical pendulum this distance is $l_r = 28.2\mathrm{cm}$

Accordingly, a thread pendulum with $l_r = 28.2\mathrm{cm}$ should also have the same oscillation period as the pendulum which can pivot around the suspension points A on the left or C on the right. The centre of gravity of the physical pendulum (of the lever) lies on the line connecting these two points.

Evaluation 2

The thread pendulum having a pendulum length $l = l_r$ has the same oscillation period as the physical pendulum from Experiment 1 , which oscillates around the points A on the left or C on the right. Label the lengths I and /r on the demonstration board with the white board pen (as in Fig. 2).

The physical pendulum is also termed a reversion pendulum because it must be reversed if one desires to change to suspension points and still have the pendulum oscillate with the same oscillation period.

Remarks

The following is true for the oscillation period of thephysical pendulum:

$T = 2\pi * \sqrt[2]{l_r/D} = 2\pi * \sqrt[2]{J_A(m*g*s)}$ mit

J_A = The moment of inertia for rotation around the axis through the point A,

l_r = The reduced pendulum length,

m = The mass of the pendulum,

s = The distance between point A and the centre of gravity S.

In addition, the following is true:

$J_A = J_s + m * s^2$

J_s = The moment of inertia for rotation around the axis through the centre of gravity S.

For a (thin) rod $J_S = m * l^2/12$ where l = The total length of the rod (in this case: the lever).

From this it follows that:

$l_r/g = J_A/(m*g*s) = (J_S + m*s^2)/(m*g*s)$,

$l_r/g = (m*l^2/12 + m*s^2)/(m*g*s)$,

$l_r = l^2/(12s) + s$

For the pendulum consisting of the lever where l = 42.8 cm and s = 21 cm:

$l_r = (42.8cm)^2/(12*21cm) + 21cm$,

$l_r = 7.3cm + 21cm = 28,3cm$ (vgl. Auswertung 1).

In Experiment 2 one can also proceed by allowing the physical pendulum to oscillate around point A and by changing the length of the thread pendulum (by moving the hook) until the oscillation periods of the pendulums are equal. If the pendulum length l of the thread pendulum is now measured, one obtains $l = l_r$ as a good approximation.

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