VARIABLE G PENDULUM

EXPERIMENT PROCEDURE:

- **Measure the period T as a function of the effective component of the gravitational acceleration g_{eff}.**
- **Measure the period T for various pendulum lengths L.**

OBJECTIVE

Measure the period of an oscillating pendulum as a function of the effective component of the gravitational acceleration.

SUMMARY

The period of a pendulum is lengthened by tilting its axis away from the horizontal, since the effective component of the gravitational acceleration is reduced.

REQUIRED APPARATUS

Quantity	Description	Number
1	Variable g Pendulum	**1000755**
1	Support for Photogate	**1000756**
1	Photo Gate	**1000563**
1	Digital Counter (230 V, 50/60 Hz)	**1001033 or**
	Digital Counter (115 V, 50/60 Hz)	**1001032**
1	Tripod Stand 150 mm	**1002835**
1	Stainless Steel Rod 470 mm	**1002934**

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BASIC PRINCIPLES

The period of a pendulum is determined mathematically by the length of the pendulum L and the acceleration due to gravity g. The effect of the gravitational acceleration can be demonstrated by tilting the axis of the pendulum so that it is no longer horizontal.

When the axis is tilted, the component of the gravitational acceleration g that is parallel to the axis g_{par} is rendered ineffective by the fact that axis is fixed (see Fig.1). The remaining component that is effective g_{eff} is given by the following equation:

(1) $$g_{eff} = g \cdot \cos\alpha$$

α: is the inclination of the axis to the horizontal

When the pendulum is deflected by an angle φ from its rest position a suspended weight of a mass m experiences a returning force of the following magnitude:

(2) $$F = -m \cdot g_{eff} \cdot \sin\varphi$$

For small angles the equation of motion of the pendulum comes out as the following:

(3) $$m \cdot L \cdot \ddot{\varphi} + m \cdot g_{eff} \cdot \varphi = 0$$

The pendulum's angular frequency of oscillation is therefore:

(4) $$\omega = \sqrt{\frac{g_{eff}}{L}}$$

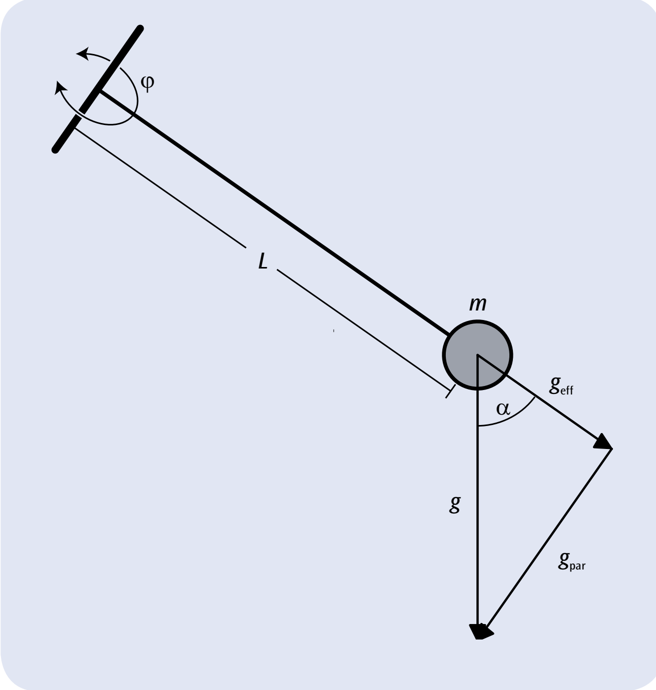

Fig. 1: Variable g pendulum (schematic)

EVALUATION

Equation (4) implies that the period of the pendulum is as follows:

$$T = 2\pi \sqrt{\frac{L}{g_{eff}}}$$

Thus, shortening the pendulum causes the period to be shorter and reducing the effective component of the gravitational acceleration makes the period longer.

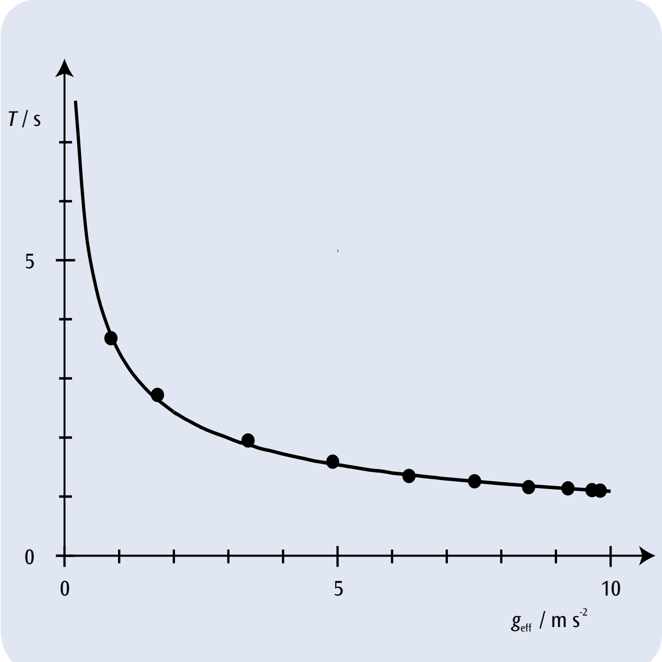

Fig. 2: Period of the pendulum as a function of the effective component of the gravitational acceleration.
Line calculated for pendulum length L = 30 cm.