Maritime University of Szczecin

Faculty of Marine Engineering

Department of Physics and Chemistry

Physics Laboratory

Laboratory Description

Determination of the gravitational acceleration using a reversible pendulum

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Objectives:

- Analysis of the rotational motion of the rigid body for a reversible pendulum.
- Determination of the gravitational acceleration.

Questions and problems to solve:

- Law of gravitation. The gravitational acceleration and a body weight.
- Construction of reversible pendulum. What is the reduced length of a pendulum?
- Equation of motion of the compound pendulum.
- What does the period of oscillation of the compound pendulum depend on?
- Moment of inertia of a rigid body.
- Steiner's theorem.

Short description:

A reversible pendulum consists of a metal bar on which two prisms O_1 and O_2 are placed at a distance L. Two prisms have sharp ends pointed to each other. These prisms define fixed rotation axes. The center of mass of the pendulum can be changed by moving massive lenses S_1 and S_2. For a properly selected distance between the lenses, the oscillation periods of the pendulum on both prisms are the same. It means that the distance L between them is so called reduced pendulum length, and its oscillation period is described by the relation:

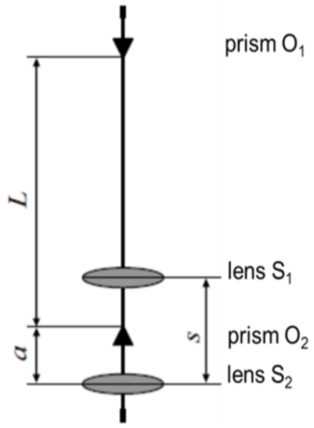

Fig. 1. Reversible pendulum

$$T = 2\pi\sqrt{\frac{L}{g}} \tag{1}$$

Prisms O_1 and O_2 and lens S_2 are placed according to the instruction. We hang the pendulum on the prism O_1. Setting the position of the lens S_1, we measure the time t_1 of ten whole pendulum's oscillations depending on the distance s between the lenses. Afterwards, we hang the pendulum on the prism O_2. Again we replace the lens S_1 and measure the dependence of time t_2 of ten whole pendulum's oscillations as a function of a distance s between the lenses. On basis of time t_1 and t_2 we calculate oscillation periods. On one graph we draw the dependence of oscillation periods T_1 and T_2 of the pendulum on the distance s between the lenses. The drawn curves will cross at two points, where abscissas equal to s_1 and s_2, and ordinate equals to T_L.

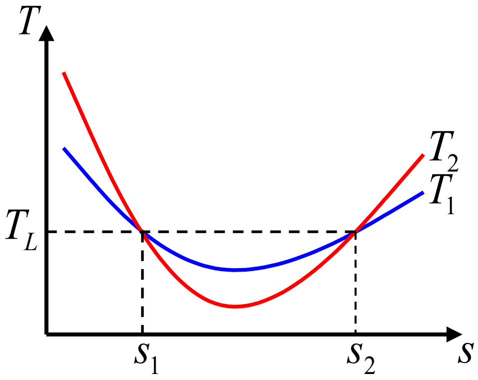

Fig. 2. The dependence of oscillation period T of the pendulum on the distance s between the lenses

By transforming the equation (1) we calculate the gravitational acceleration:

$$g = 4\pi^2 \frac{L}{T_L^2} \tag{2}$$

Literature:

1. Resnick R., Halliday D., Walker J., *Fundamentals of Physics*, John Wiley & Sons, INC (available editions).