T.C.

GEBZE TECHNICAL UNIVERSITY

PHYSICS DEPARTMENT

PHYSICS LABORATORY I

EXPERIMENT REPORT

THE NAME OF THE EXPERIMENT

Determining the restoring torque of the torsion axle

<u>PREPARED BY</u>

NAME AND SURNAME:

STUDENT NUMBER :

DEPARTMENT :

Signature:

Experimental procedure for determining the restoring torque of the torsion axle

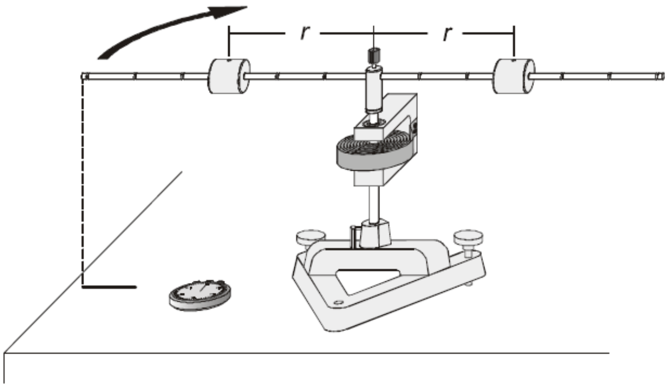
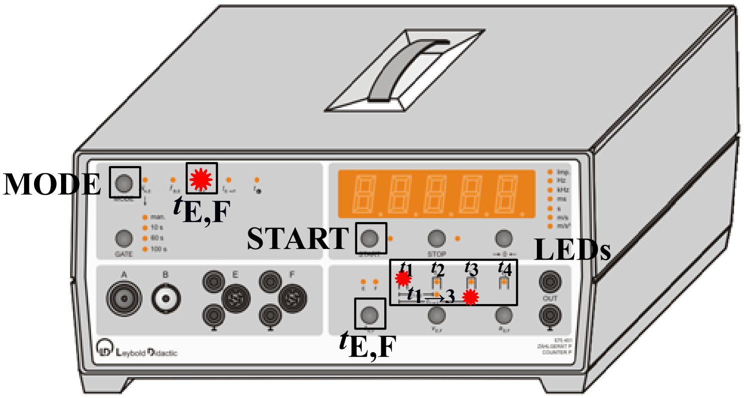


Figure 6.2: Experimental setup for determining the period of oscillation.

The experimental setup is illustrated in Fig. 6.2.

1. Fix the middle of the transverse rod to the torsion axle arrange the weights symmetrically at a distance of 10 cm from the torsion axle.
2. Locate the transverse rod so that it is in the photo gate in its equilibrium (rest) position.
3. Set the operation *MODE* on the digital counter to the symbol $t_{E,F}$ for measuring the period.
4. Rotate the transverse rod to the right by < 180°, press the start button of the digital counter and release the rod. Wait until all the display of storage LED's light up.



5. Read the period *T* by pressing pushbutton $t_{E,F}$ and select of the time $t_{1\to3}$ stored in the operation mode $t_{E,F}$ to be displayed as the measured *T* value. *In the storage display, the LED corresponding to the selected time shines more brightly than the others.*
6. Repeat the measurement three times, alternately deflecting the rod to the left and to the right.
7. One after another increase the distance to 15, 20, 25 and 30 cm, each time repeating the measurement.
8. Finally, remove the weights, and repeat the measurement for the transverse rod. Record the measured periods to the table 6.1.
9. Measure the mass of the weights *m* ____________ *gr.*

Calculate mean value of measured period of oscillation T and T^2 and fill in the Table 6.1.

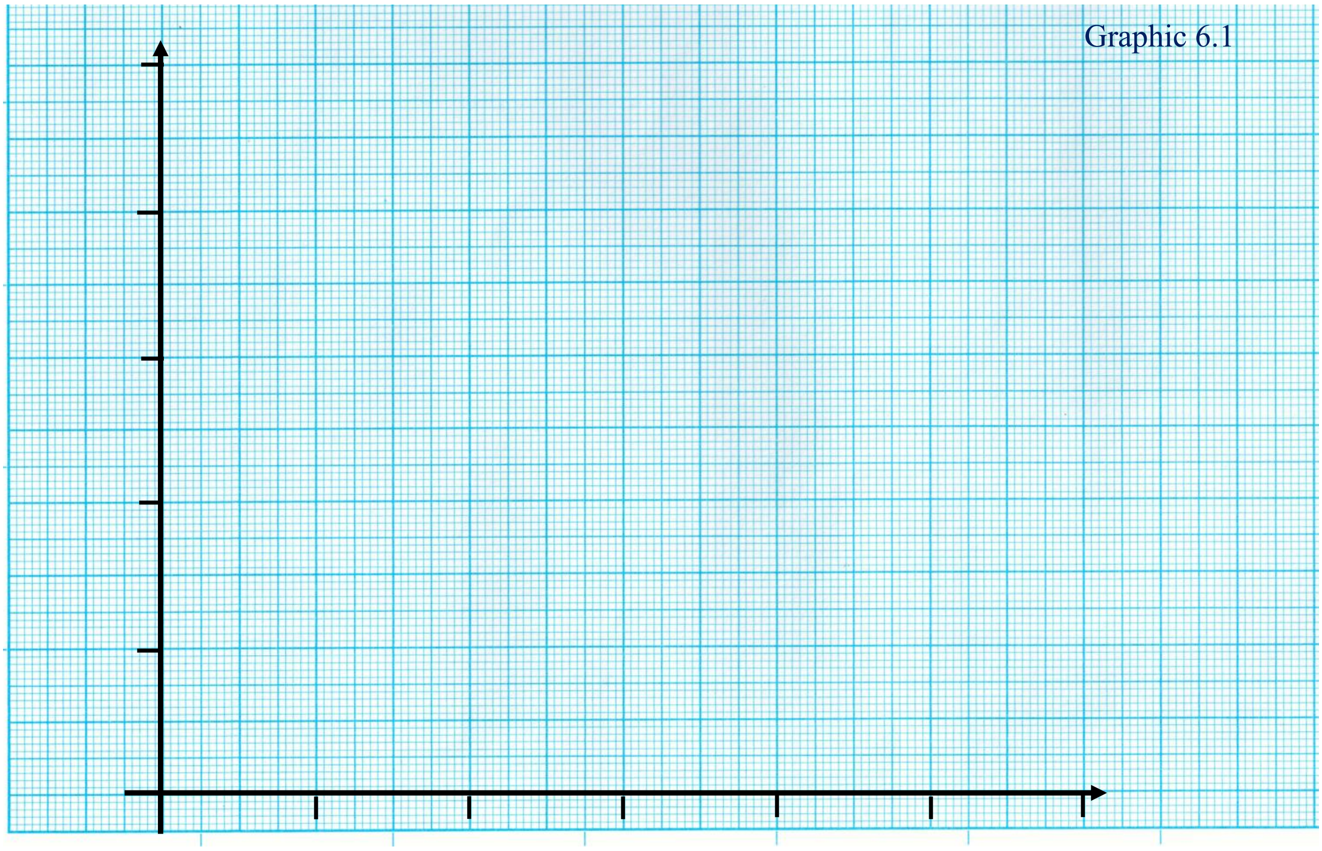
Table 6.1: Period of oscillation T for a transverse rod with weights attached at a distance r from the axis of rotation.

r (m)	r^2 (m^2)	T_1 (s)	T_2 (s)	T_3 (s)	T_4(s)	T (s)	T^2(s^2)
0.10							
0.15							
0.20							
0.25							
0.30							
Without weights							

A) $T^2 - r^2$ Plot

Use only the data from the first five rows of table 6.1, where the weights are on the axle, and plot T^2-r^2 graph on reserved milimetric space as x-axis *the square of the distance (r^2) and y-axis square of the period of oscillation (T^2).*

If we take into account our theoretical considerations we expect a line to pass through those points. The Eq. 6.6 $T^2 = \frac{8m\pi^2}{D} r^2 + T_0^2$ describes a linear ($y=ax+b$) relation between the square of the period of oscillation T^2 and the square of the distance r^2, with the slope $a = \frac{8m\pi^2}{D}$ and the intercept of the ordinate $b = T_0^2$. Use the slope a and the intercept point b, which will be calculated in the following step, plot $y=ax+b$ line on your graph. Observe the fitness of the line to your data points.



You are expected to calculate the slope $a = \frac{8m\pi^2}{D}$ The slope of the line could be calculated with the statistical fitting method called the *"least-squares method"* ***by using the data from the first five rows of table 6.1 where weights are on the axle***. The formula that is derived from the least squares method will give you the slope of the line and the intercept of the ordinate.

Calculate four terms that will be used in the equations below.

$$\sum_{i=1}^{5} r_i^2 =$$

$$\sum_{i=1}^{5} T_i^2 =$$

$$\sum_{i=1}^{5} r_i^2\, T_i^2 =$$

$$\sum_{i=1}^{5} r_i^4 =$$

Substitute those values in the equation and calculate the slope *a* and the intercept of the ordinate:

$$a = \frac{5\sum_{i=1}^{5} r_i^2\, T_i^2 - \sum_{i=1}^{5} r_i^2 \sum_{i=1}^{5} T_i^2}{5\sum_{i=1}^{5} r_i^4 - \left(\sum_{i=1}^{5} r_i^2\right)^2} =$$

$$b = \frac{\sum_{i=1}^{5} r_i^4 \sum_{i=1}^{5} T_i^2 - \sum_{i=1}^{5} r_i^2\, T_i^2 \sum_{i=1}^{5} r_i^2}{5\sum_{i=1}^{5} r_i^4 - \left(\sum_{i=1}^{5} r_i^2\right)^2} =$$

As the mass *m* is known, the restoring torque *D* can be calculated from the slope *a* according to

$D = \frac{8m\pi^2}{a} =$ (______)

What can you say about the *b* value, and which quantity of the experiment can be calculated by using the *b* value?

Conclusion, Comment and Discussion:

(Tips: Give detail explanation about what you've learned in the experiment and also explain the possible errors and their reasons.)

Signature:

Questions:

1) Two rods have the same mass and length, but the mass is distributed differently. One rod has the mass concentrated at the ends and the other has the mass concentrated at the center. The two rods are held at their centers and rotated back and forth. Which one is easier to rotate? What is a possible physical explanation for this?