T.C.
GEBZE TECHNICAL UNIVERSITY
PHYSICS DEPARTMENT

PHYSICS LABORATORY I
EXPERIMENT REPORT

THE NAME OF THE EXPERIMENT

Hooke's Law

<u>**PREPARED BY**</u>

NAME AND SURNAME:

STUDENT NUMBER :

DEPARTMENT :

Signature:

Experimental Procedure:

The experimental set-up to measure the spring constants is shown in Fig.10.1.

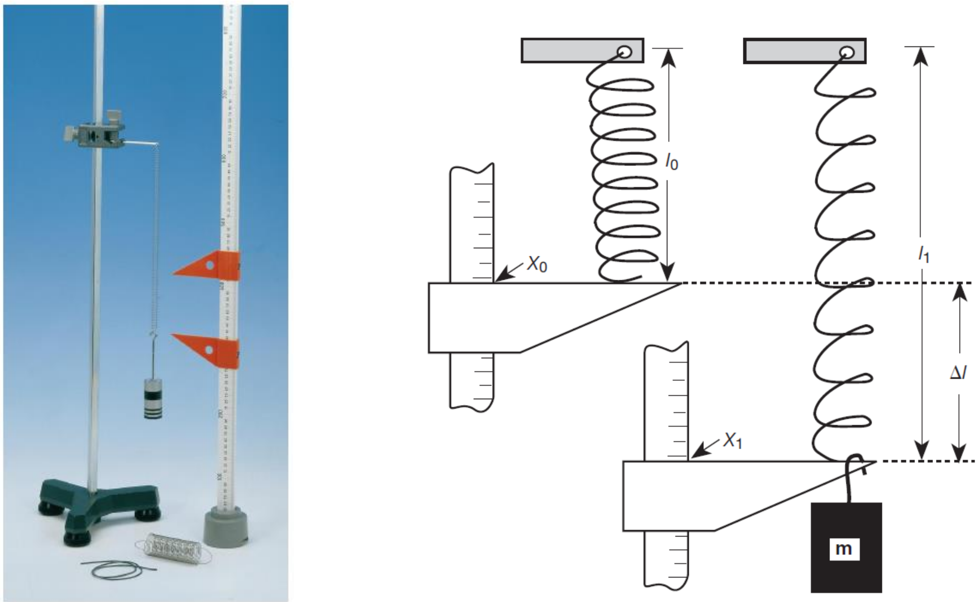


Figure 10.1: Experimental set-up: Hooke's law.

Hook's Law:

1. Measure the initial equilibrium position x_0 of each spring (thin and thick) and mass of the holder.

x_0^{thin} = _____ (cm) x_0^{thick} = _____ (cm) m_{holder} = _____ (gr)

2. Suspend a mass on the holder, then measure the displacements from the equilibrium position for each spring. Don't forget to use the total mass (additional mass + mass of the holder) attached to the spring in the calculations.

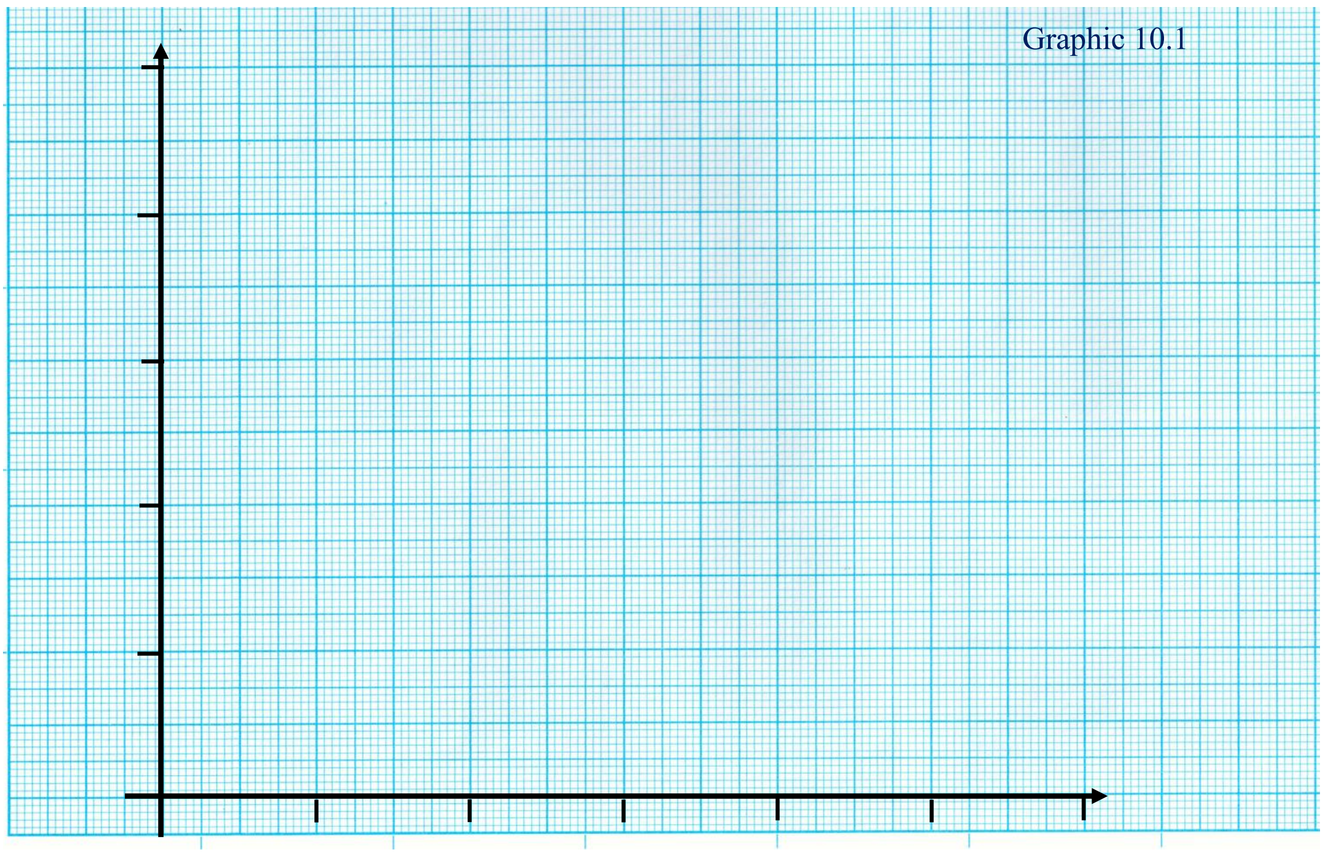
3. One after another, suspend an additional mass by 20 gr increments to a total of 100 gr and read the corresponding equilibrium position x_i, then calculate the change of length ΔL. Record the values in Table 10.1

4. Calculate the weight (force) $F = mg$ (g=980 cm/s^2) and also note these values in Table 10.1.

Table 10.1: Spring length L as a function of the suspended weights.

m (gr)	*F=mg* (gr.cm/s^2)	x_i^{thin} (cm)	$\Delta L_{thin} = x_i^{thin} - x_0^{thin}$ (cm)	x_i^{thick} (cm)	$\Delta L_{thick} = x_i^{thick} - x_0^{thick}$ (cm)
20					
40					
60					
80					
100					

Use the values in Table 10.1 and plot *F-ΔL* graphs of each spring on reserved millimetric space as *x*-axis *the change of length* (*ΔL*) and *y*-axis the force (*F*). Represent the values in the table as points on your graph.



If we take into account our theoretical considerations, we expect a line passing through those points. The Eq. 10.7 $F = -k\Delta L$ describes a linear ($y=kx$) relation between the force F acting on the spring and the change of length ΔL, with the slope spring constant k . Use the slope k and, which will be calculated in the following step, plot $y=kx$ line on your graph. Observe the fitness of the line to your data points.

You are expected to calculate the slope k. The slope of the line could be calculated using the values in Table 10.1 with the statistical fitting method called "*least squares method*".

A) Thin spring;

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

$$\sum_{i=1}^{5} \Delta L_i F_i =$$

$$\sum_{i=1}^{5} \Delta L_i^2 =$$

Substitute those values in equation and calculate the slope (spring constant) k_{thin}.

$$k_{thin} = \frac{\sum_{i=1}^{5} \Delta L_i F_i}{\sum_{i=1}^{5} \Delta L_i^2} =$$

Thin spring constant k_{thin}= (______)

B) Thick spring;

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

$$\sum_{i=1}^{5} \Delta L_i F_i =$$

$$\sum_{i=1}^{5} \Delta L_i^2 =$$

Substitute those values in the equation and calculate the slope (spring constant) k_{thick}

$$k_{thick} = \frac{\sum_{i=1}^{5} \Delta L_i F_i}{\sum_{i=1}^{5} \Delta L_i^2} =$$

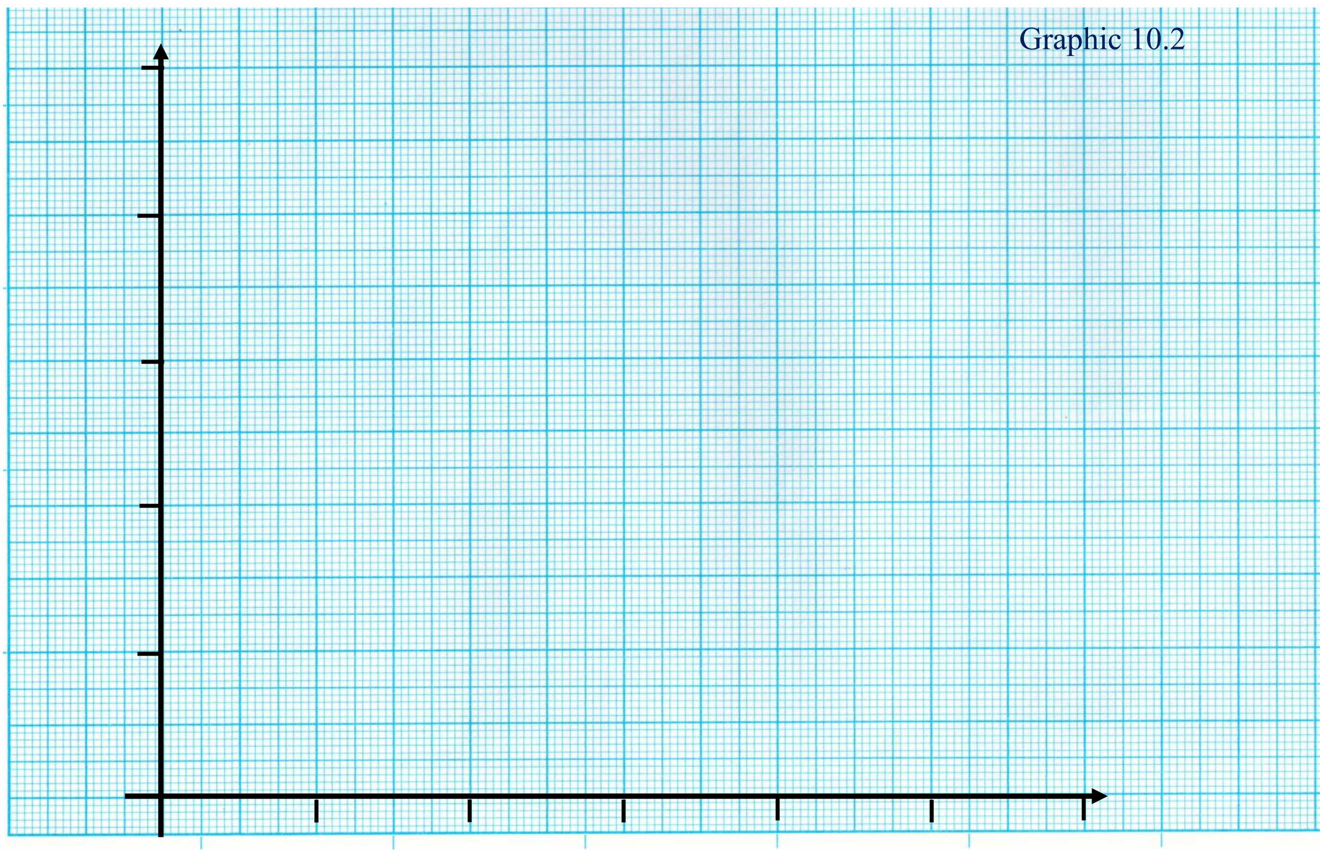
Thick spring constant k_{thick}= (______)

Harmonic oscillation:

1. In this step, suspend the same masses on each spring in turn. Pull the mass little bit down then release. Measure the time of the oscillation of the spring to complete 10 cycles for each mass by using the stopwatch. Divide each time by 10 to find the time for one period for each mass and record the values in table 10.2.
2. Calculate the period of oscillation T and square of the period of oscillation T^2 and fill in Table 10.2.

Table 10.2: Period of oscillation T as function of the suspended mass.

m (gr)	Δt_{thin} (s)	$T_{thin} = \frac{\Delta t_{thin}}{10}$ (s)	T^2_{thin} (s^2)	Δt_{thick} (s)	$T_{thick} = \frac{\Delta t_{thick}}{10}$ (s)	T^2_{thick} (s^2)
20						
40						
60						
80						
100						


Graphic 10.2

Use the values in the Table 10.2 and plot T^2-m graph for both spring on the same graph with x-axis *the mass* (m) and y-axis *square of the period of oscillation* (T^2). Represent the values in the table 10.2 as points on your graph. If one takes squares of both sides of the Eq. 10.7, $T^2 = \frac{4\pi^2}{k} m$ is obtained and this equation describes a linear ($y=ax$) relation between the square of the period of oscillation T^2 and the mass m, with the slope $a = \frac{4\pi^2}{k}$. Use the slope a and, which will be calculated in the following step, plot $y=ax$ line on your graph. Observe the fitness of the line to your data points.

You are expected to calculate the slope $a = \frac{4\pi^2}{k}$. The slope of the line could be calculated using the values in the table 10.2 with the statistical fitting method called "*least squares method*".

A) Thin spring;

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

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

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

Substitute those values in equation below and calculate the slope a.

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

The spring constant k_{thin} can be calculated from the slope a according to

$$k_{thin} = \frac{4\pi^2}{a} =$$ (______)

B) Thick spring;

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

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

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

Substitute those values in equation below and calculate the slope a.

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

The spring constant k_{thick} can be calculated from the slope a according to

$$k_{thick} = \frac{4\pi^2}{a} =$$ (______)

Signature:

Compare the spring constants k_{thin} and k_{thick} values calculated by using the Hook's law and harmonic oscillation with each other. Discuss the reasons for probable differences.

Conclusion, Comment and Discussion:

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

Signature:

Questions:

1) When you measure the period of the same spring at *the poles* and near *the equator*, do you observe any difference? How do you explain this?

2) A mass m is hanged to a 10 cm spring with a spring constant k and the system performs a simple harmonic motion. Then the spring is divided into two pieces as 3 cm and 7 cm. The same m mass is hanged to both springs. How do the period and the spring constants change? Please explain.

Signature: