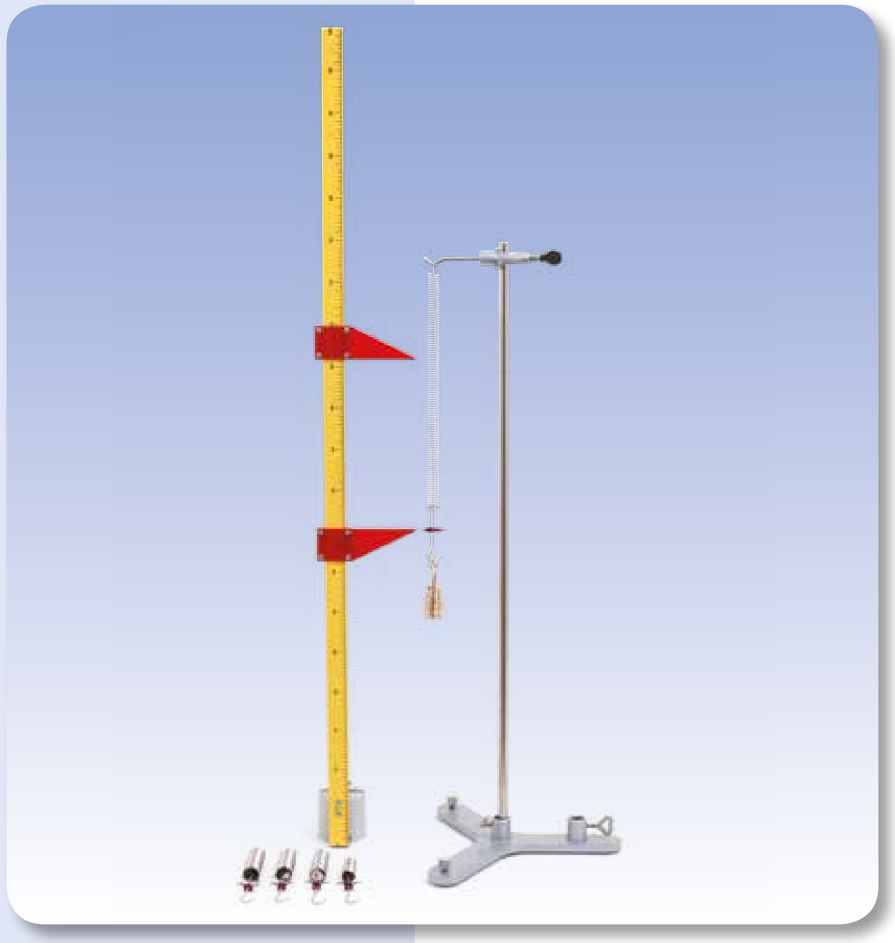

OBJECTIVE

Confirm Hooke's law for coil springs under tension

EXPERIMENT PROCEDURE

- **Confirm Hooke's law and determine the spring constant of five different coil springs.**
- **Compare the measured spring constants with those calculated theoretically.**

SUMMARY

In any elastic body, extension and tension are proportional to one another. This relationship was discovered by *Robert Hooke* and is frequently demonstrated using a coil spring with weights suspended from it. The change in the length of the spring is proportional to the force of gravity *F* on the suspended weight. In this experiment, five different coil springs will be measured. Thanks to a suitable choice of wire diameter and coil diameter, the spring constants all span one order of magnitude. In each case, the validity of Hooke's law will be demonstrated for forces in excess of the initial tension.

REQUIRED APPARATUS

Quantity	Description	Number
1	Set of Helical Springs for Hooke's Law	1003376
1	Set of Slotted Weights, 20 – 100 g	1003226
1	Vertical Ruler, 1 m	1000743
1	Set of Riders for Rulers	1006494
1	Barrel Foot, 1000 g	1002834
1	Stainless Steel Rod 1000 mm	1002936
1	Tripod Stand 150 mm	1002835
1	Clamp with hook	1002828
Additionally recommended		
1	Callipers, 150 mm	1002601
1	External Micrometer	1002600

You can find technical information about the equipment at 3bscientific.com

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BASIC PRINCIPLES

In any elastic body, extension and tension are proportional to one another. This relationship was discovered by *Robert Hooke* and is a good description of how a large number materials behave when the degree of deformation is sufficiently small. This law is frequently demonstrated using a coil spring with weights suspended from it. The change in the length of the spring is proportional to the force of gravity *F* on the suspended weight.

For the sake of greater precision, it is first necessary to determine the initial tension which may be exhibited by the spring as the result of its manufacturing process. It is necessary to compensate for this by adding a weight which applies a force F_1, causing the spring to extend from its natural length without any weight s_0 to a length s_1. For weights in excess of F_1, Hooke's law applies in the following form:

(1) $$F - F_1 = k\cdot(s - s_1),$$

This is so as long as the length of the spring *s* does not exceed a certain critical length.

The spring constant *k* depends on the material and the geometric dimensions of the spring. For a cylindrical coil spring with *n* turns of constant diameter *D*, the following is true:

(2) $$k = G\cdot\frac{d^4}{D^3}\cdot\frac{1}{8\cdot n}.$$

d: Diameter of wire coils of spring

The shear modulus *G* for the steel wire forming the spring's coils is 81.5 GPa.

In this experiment, five different coil springs will be measured. Thanks to a suitable choice of wire diameter and coil diameter, the spring constants all span one order of magnitude. In each case, the validity of Hooke's law will be demonstrated for forces in excess of the initial tension.

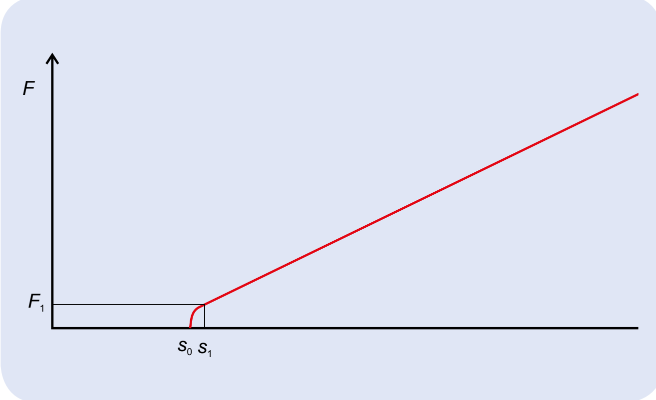

Fig. 1: Schematic of characteristic curve for a spring coil of length *s* with a certain initial tension

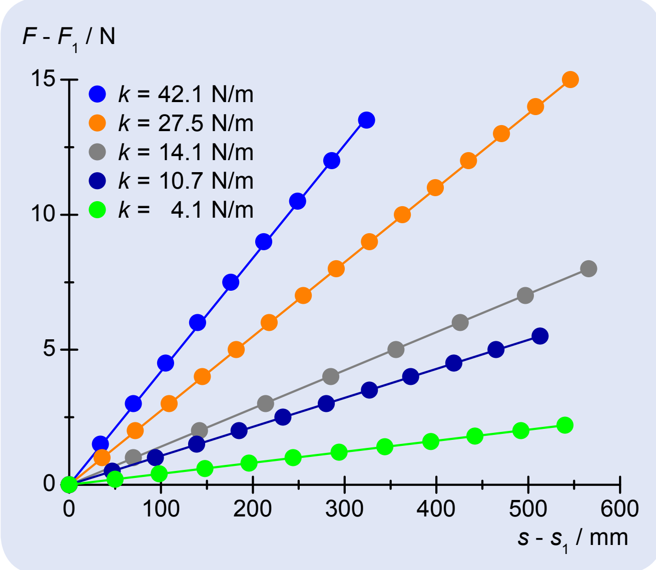

Fig. 2: Load as a function of the change in length

EVALUATION

The force of gravity *F* can be determined to sufficient precision from the mass *m* of the weight as follows:

$$F = m\cdot 10\frac{\text{m}}{\text{s}^2}$$