EXPERIMENT 2

Hooke's Law

GOAL

- To investigate Hooke's Law
- To determine the spring constant

THEORY

Consider an ideally elastic spring in equilibrium (state of rest). If we stretch or compress the spring, a force will arise to bring it back to the equilibrium position. Assume that one end of the spring is fixed to a wall, and an object is attached to another end. If we move the object away from the wall, the force exerted by the spring will pull it back (toward the wall); if we move the object toward to the wall, the spring will push it away from the wall (Fig. 1).

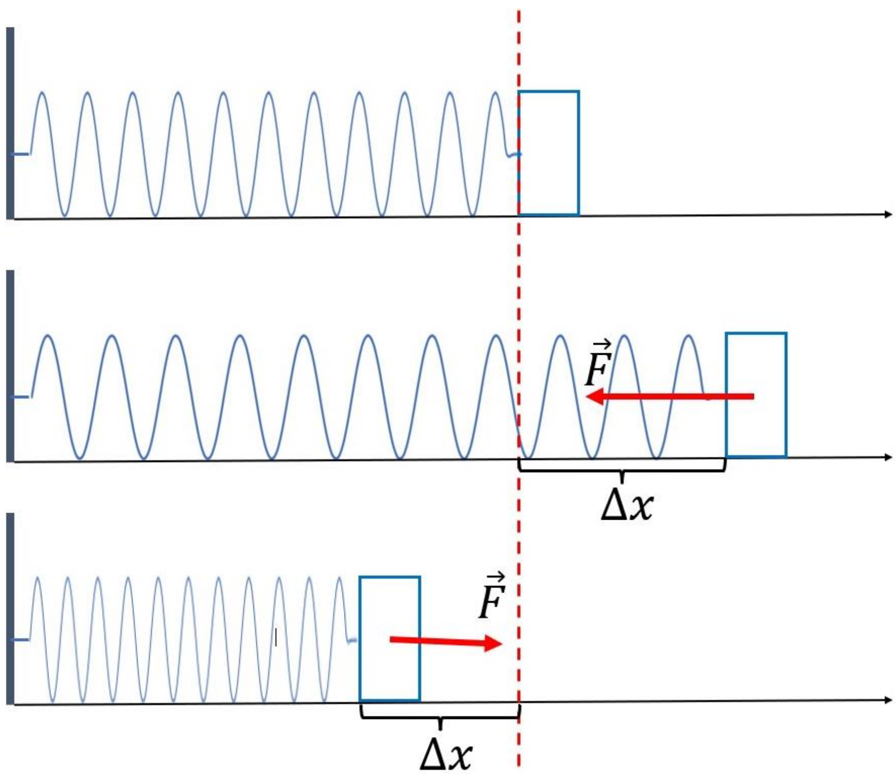

Fig. 1. Force exerted by the stretched and compressed springs

The magnitude of this force is proportional to the change of the length of spring:

$$F = -k\Delta x \qquad (1)$$

where Δx is the change in the length of the spring, and k is the coefficient of proportionality. It is called the ***spring constant***. We use the negative sign in formula (1) because the force F is always in the direction opposite to the displacement of the object. The formula, which is true for ideal springs, is called Hook's Law, after the famous English scientist and mathematician Robert Hooke (1635 – 1703).

Consider a spring horizontally hung from support (Fig. 2). If we attach a bob with the mass of m to a free end of the spring, it will be stretched and stop at a lower position.

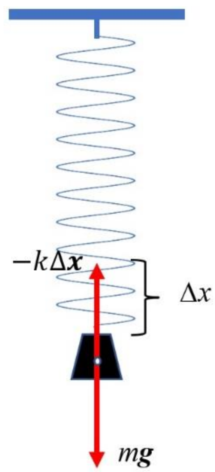

Fig. 2. Horizontally hung spring

Assume that the change in the length of the spring is Δx. Since the bob is in the state of rest, the magnitudes of forces exerted by the spring and the gravity will be equal:

$$k\Delta x = mg \qquad (2)$$

where m is the mass of the bob, g is the local gravitational acceleration of Earth.

We can determine the spring constant from this equality:

$$k = \frac{mg}{\Delta x} \qquad (3)$$

PROCEDURE

To perform this experiment, follow a five-step procedure:

1. Hang a spring from support.
2. Measure the initial length x_0 of the spring.
3. Attach a bob with a known mass to the free end of the spring and measure the length of the spring.

4. Repeat step 3 for other bobs with available known masses and complete the table below considering that g = 9.8 m/s^2:

Table 1

m (kg)	x_0 (m)	x (m)	$\Delta x = x - x_0$ (m)	$k\ (N/m)$

5. Determine the spring constant as the average of the experimental values obtained from the last column of Table 1.