Hooke's law

The aim of Experiment:

1. To investigate Hooke's Law (The relation between force and stretch for a spring).
2. Determine the spring constant for an individual spring.

Theory:

Hooke's law relates the force pulling or pushing on a spring (or other elastic material) to the amount the spring stretches or compresses.

The force exerted by a spring to restore itself to its natural length is referred to as the **restoring force**. When a spring is stretched (as in this experiment) the restoring force is exerted inward; if a spring is compressed, the restoring force is exerted outward.

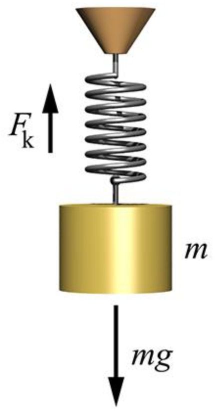
Mathematically, the restoring force of a spring is expressed as:

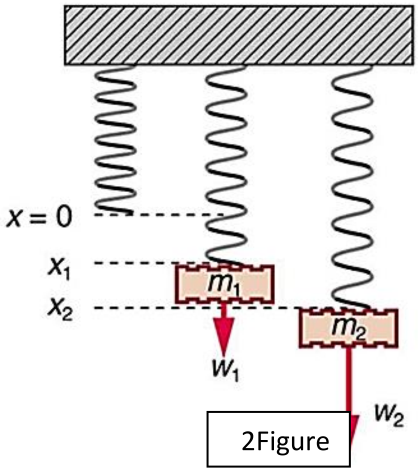
$$F = -kx$$

Where F**:** restoring force, k: proportionality constant, called the **spring constant**, x: distance the spring has been stretched or compressed.

The negative sign indicates that the restoring force acts in the direction opposite of the displacement direction.

When a mass, m, is suspended from a spring and the system is allowed to reach equilibrium, as shown in Figure 1, Newton's Second Law tells us that the magnitude of the spring force equals the weight of the body, $F = mg$. Therefore, if we know the mass of a body at equilibrium, we can determine the spring force acting on the body.





2Figure

Depending on material, length, diameter, and number of coils, each spring has its unique spring constant. The greater the spring constant, the stiffer the spring (the more difficult it is to stretch it or compress it).

The **elastic limit** is the maximum extension to which a spring can be stretched without permanent deformation and still return to its original shape. If a spring is stretched beyond its elastic limit, it will not return to its original shape and will remain deformed.

On a force versus elongation graph, the elastic limit will show up as the point where the slope of the line changes or where the straight-line portion of the graph ends.

Commonly, a Hooke’s law experiment is conducted by adding increasing masses to a spring and recording the cumulative stretch (elongation) of the spring.

Tools used:

A spring,

Clamp Stand

Weights and

A measuring ruler.

Method of working:

1. Set up the tools as shown in the diagram (Figure 2).

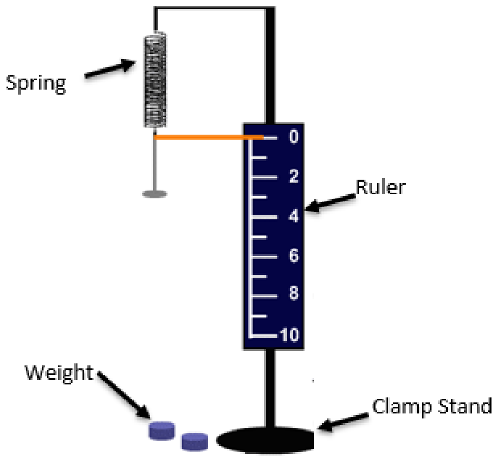


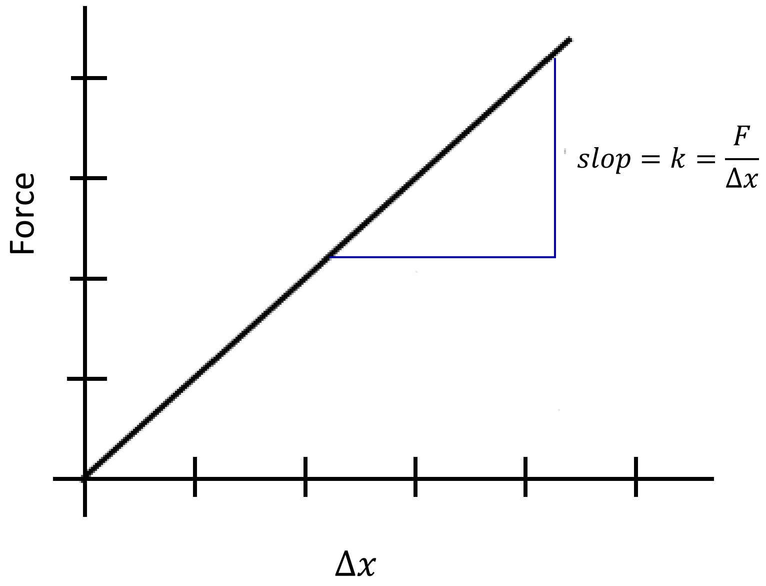
Figure 2

2. Attach a mass hanger directly to the bottom of the hanging spring and record the position of the bottom of the mass hanger relative to a meter stick.
3. Hang a weight from the spring and wait for it to come to rest.
4. Record the final position of the mass hanger.
5. Calculate increase in length and note in the "Observation Table".

M (kg)	F (N)= M × g	$\Delta x = (x_2 - x_1)$ $= (x_2 - 0)$ (cm)

6. Repeat the above steps with different weights.

7. Plot a graph with your readings. Force applied (mass × gravity) vs Increase in length (Δx =Final length - Initial Length).



Questions of the experiment:

1. The force required to stretch Hooke's Law spring varies from **0 N** to **65 N** as we stretch the spring by moving one end **6.3 cm** from its unstressed position. Find the force constant of the spring. Answer in units of **N/m.**
2. An object with mass of 630 g is hung on a spring. What is the force of the object acting on the spring?
3. Will a strong spring have a big or small constant?
   a) Small
   b) Big