Hooke's law

General Physics Laboratory (PHY119) Fall 2014

1 Introduction

Elastic materials are materials that retains their original shape after being deformed by an applied force. The response to an applied force differs from elastic material to another. This difference is characterised by a constant k, which is called the stiffness of the elastic material. In this experiment, we will take the spring as an example of elastic materials and try to calculate the spring constant or the spring stiffness k.

2 Objective

1. Determining the spring constant (k) by using Hook's law.

3 Theory

Hooke's law is the law of elasticity, which states that the extension or displacement Δx of the spring is directly proportional to the restoring force F_s. We can express it mathematically as:

$$F_s \propto -\Delta x \tag{1}$$

The minus sign indicates that the force is opposite the direction of the displacement. Removing the proportionality sign,

$$F_s = -k\Delta x \ , \tag{2}$$

where k is the constant of the spring. If the spring is suspended vertically, and a ball of mass m is attached to the end of the spring, then the restoring force will have the same magnitude as the gravitational force on the mass. This is because, the spring is at equilibrium, and the only forces acting on it are the gravitational and the restoring force. Hence, they should be equal to cancel out. Therefore, we could write Hooke's in terms of the applied force ($F = mg$) as,

$$-F = -k\Delta x \ , \tag{3}$$

Equation 3 can be used to find the spring constant in terms of the applied force, which can be found by multiplying the mass on the spring with the gravitational acceleration,

$$k = \frac{F}{\Delta x} \tag{4}$$

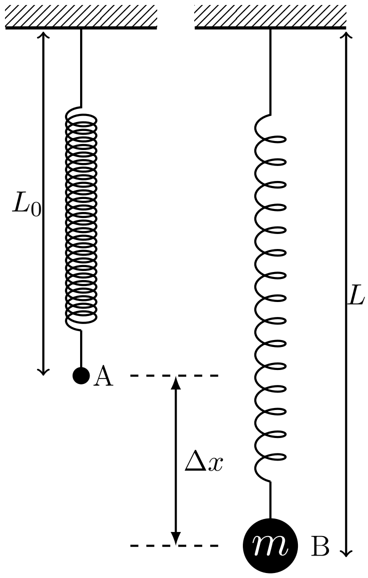

Figure 1: Extension of the spring

4 Equipment

- Clamp
- Base
- Spring
- Masses.

5 Procedure

1. Hang the spring in the clamp and measure the length of the spring L_0 .
2. Hang the mass 50g on the spring and take the new length of the spring L .
3. Find $\Delta x = L - L_0$ and record your result on the table.

m (g)	m (kg)	L (cm)	Δx (cm)	Δx (m)	F (N)

4. Repeat step 2 to 3 for different masses (100g-150g...).
5. Calculate the applied force F for each mass.
6. Plot a graph between Δx and F .
7. Draw the best line and find its slope.
8. Calculate the spring constant k from the slope.