## Objective

To verify the validity of Hooke's law and determine the spring constant.

## Apparatus

Hooke's law apparatus, Weights, scale, stand. Hanger.

## Theory

### HOOK'SLAW

The Hooke's Law Apparatus is a practical application of hook's law of elasticity. This law is an approximation that states that the extension of a spring is in direct proportion with the load applied to it. Many materials obey this law as long as the load does not exceed the material's elastic limit. Materials for which Hooke's law is a useful approximation are known as linear-elastic or "Hookean" materials. Hooke's law in simple terms says that strain is directly proportional to stress.

Mathematically, Hooke's law states that

Where

$$F = -kx$$

- **X** is the displacement of the spring's end from its equilibrium position (a distance, in SI units: meters);
- **F** is the restoring force exerted by the spring on that end (in SI units: N or kg•m/s2);and
- **K** is a constant called the rate or spring constant (in SI units: N/m or kg/s2).

When this holds, the behavior is said to be linear. If shown on a graph, the line should show a direct variation. There is a negative sign on the right hand side of the equation because the restoring force always acts in the opposite direction of the displacement (for example, when a spring is stretched to the left, it pulls back to the right).

When forces act on a solid body, the resulting deformation (translation and rotation movements are suppressed in the following) depends to a large extent on the material as well as on the size and on the direction along which the exterior forces act. When the solid body regains its original shape after the exterior force stops acting, that is, the interior restoring forces of the material can bring the solid body back to its original equilibrium position, the material is called elastic.

A helical spring is a very simple example of an elastic body (Fig.3). In addition, if deviations $\Delta l$ from the equilibrium position $l0$ of the helical spring are not very large, the restoring force $FR$ of the spring is found to be proportional to its elongation (or to its compression) $\Delta l$:

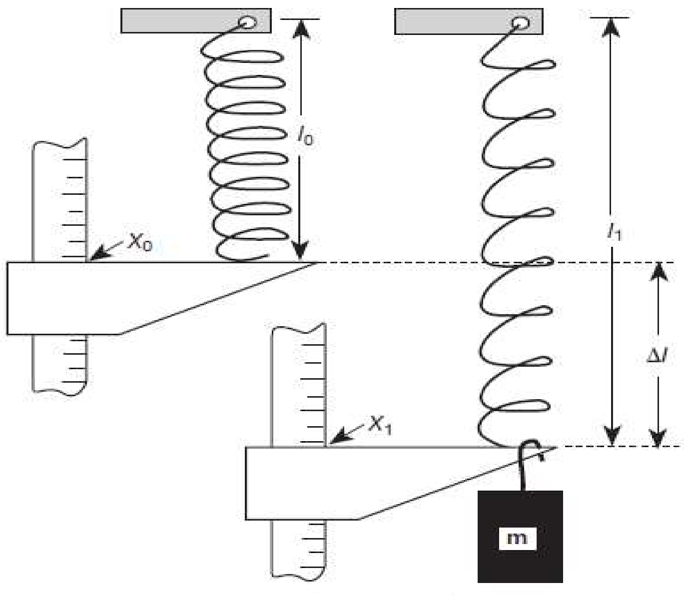


***Figure 10 Hooke's Law Apparatus***

This is Hooke's law or the linear law of forces, where the proportionality constant D, which is a general magnitude of reference, is called the spring constant in the case of a helical spring. If an exterior force acts on the spring, such as the weight $F_W = m \cdot g$ of a mass m (g = 9.81 m/s2: acceleration of terrestrial gravity) in this experiment, a new stable equilibrium is reached for the length of the spring , for which the weight mass m is  equal to the restoring force of the spring.

The elongation of the helical spring is therefore proportional to the forces $F_W$ exerted by the weights:

as is also shown by the characteristic curves of a helical springs . The slope of the characteristic curves is the respective spring constant $K$ of the helical springs.

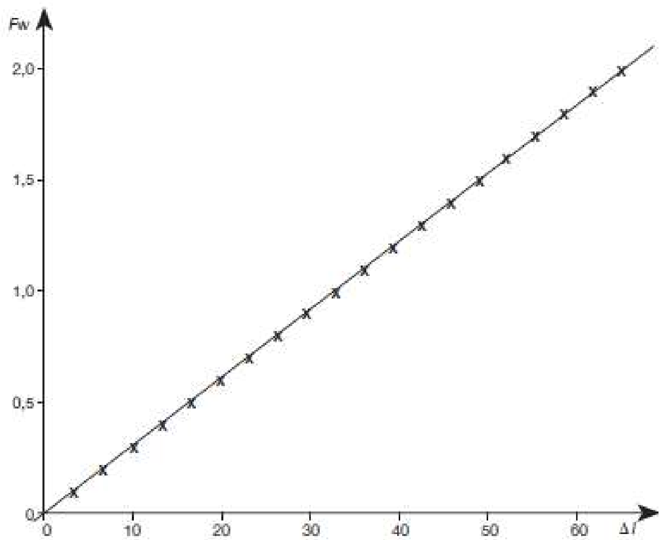


***Figure 11 characteristic curves of a helical springs***

Thus, forces required to cause a given elongation of the spring increase proportionally with the spring constant.

## Procedure:

The first step is to note down the initial reading on the scale. After that apply load on the hanger and checked the extension produced in the spring this procedure is continued for four readings. After that it is unloaded an again note the reading .calculate the spring constant by given formula.

## Unit Assembly

***Figure 12 Unit Assembly***

## Observations

Initial length $l_o$: _______________
Initial position $x_o$: _____________

**For soft spring**

| Sr.# | Force(N) | Loading | Unloading | Mean | Change In Length ΔL | K=F\ ΔL(exp) | K(Th) |
|---|---|---|---|---|---|---|---|
| 1 | 0.5 | | | | | | |
| 2 | 1.0 | | | | | | |
| 3 | 1.5 | | | | | | |
| 4 | 2.0 | | | | | | |

**For Hard Spring**

| Sr.# | Force(N) | Loading | Unloading | Mean | Change In Length ΔL | K=F\ ΔL(exp) | K(Th) |
|---|---|---|---|---|---|---|---|
| 1 | 3 | | | | | | |
| 2 | 6 | | | | | | |
| 3 | 9 | | | | | | |
| 4 | 12 | | | | | | |

**Procedure (Students' own words)**

**Difficulties / Suggestions**

**Concluding Remarks / Comments**

**Questions**

1. **Various methods to calculate spring constant?**

2. **Why the values of experimental and theoretical spring constant different?**

3. **How to improve experimental procedure?**