EXPERIMENT : HOOKE'S LAW

OBJECTIVES

In this experiment, you can learn about the oscillation period and frequency, harmonic oscillation, the spring constant, and Hook's law.

Finally the oscillation period of a spring is measured and the spring constant is determined.

THEORY

A simple kind of oscillation occurs when the restoring force F is directly proportional to the displacement from equilibrium x. This happens if the spring (Fig. 7.1) obeys Hooke's law. Hooke's Law gives the relationship between the force applied to an unstretched spring and the amount the spring is stretched:

$$F = -kx \tag{7.1}$$

where k is the spring (or force) constant.

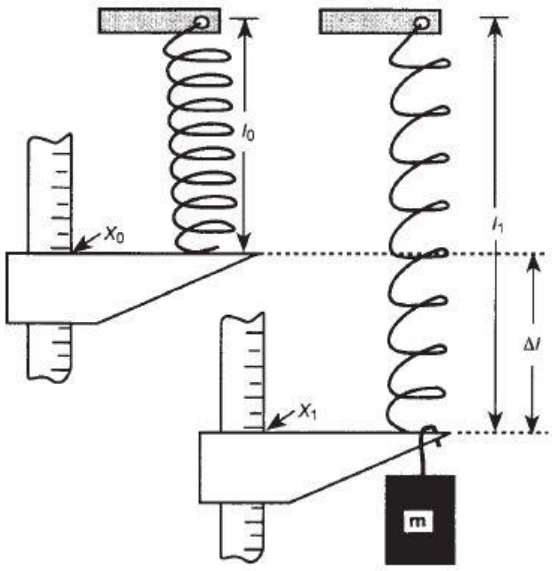

Figure 7.1 Stretching a spring from elongation x_0 to elongation x_1.

Using the Newton's second law of motion Eq. (7.1) becomes

$$F = m\frac{d^2x}{dt^2} = -k\,x \tag{7.2.a}$$

or

$$\frac{d^2x}{dt^2} + \frac{k}{m}x = 0. \tag{7.2.b}$$

This equation is the differential equation of simple harmonic motion. The wave function of Eq. (7.2) describes the displacements of mass:

$$x = A \sin\ \omega t + \delta \tag{7.3.a}$$

or

$$x = A \cos\ \omega t + \delta \tag{7.3.b}$$

where A is the amplitude and δ phase angle.

One can calculate the period of the motion using the angular frequency $\omega = \frac{2\pi}{T}$ for small amplitude:

$$T = 2\pi\ \sqrt{\frac{m}{k}}\,. \tag{7.4}$$