Simple Harmonic Oscillation

TOPICS AND FILES

Mechanics Topic

Harmonic motion; multiple springs

Capstone File

36 Oscillation.cap

EQUIPMENT LIST

Qty	Items	Part Numbers
1	PASCO Interface (for one sensor)	
1	Photogate/Pulley System	ME-6838
1	Dynamics System Photogate Bracket	ME-9806
2	Spring (*k* from 3.5 to 8 N/m)	ME-9803 or SE-8749
1	1.2 m Dynamics Track	ME-9435A
1	Dynamics Cart with Friction Pad	ME-9430
1	Dynamics Cart Five-Pattern Picket Fence	ME-9804
1	Balance	SE-8723
1	Large Rod Base	ME-8735
2	Rod, 45 cm	ME-8736
1	Hooke's Law Spring Set	SE-8749
1	Mass and Hanger Set	ME-9348
1	Double Rod Clamp	ME-9873
1	Ruler or Meterstick	

INTRODUCTION

This lab has two parts.

The purpose of Experiment 1 is to use Hooke's law to determine the spring constants, k, of two springs that will be used in Experiment 2. By using a ruler to measure displacement (stretching) of the springs and different masses, k can be measured directly.

The purpose of Experiment 2 is to investigate the motion of a cart that is oscillating back and forth as it is pulled by springs attached at each end of the cart, and to examine the changes caused by the introduction of friction by the cart's friction pad. The photogate functions to measure the motion of the cart, and the *Capstone* program will record and display data of the motion. Ultimately, the student is asked to determine the damped and undamped frequencies, period, and spring constant of the cart-spring system based on indirect calculation, which will be compared to measured values.

BACKGROUND

A spring that is hanging vertically from a support with no mass at the end of the spring has a length, L, (called its rest length). When a mass is added to the spring, its length increases by ΔL. The equilibrium position of the mass is now a distance, $L + (\Delta L)$, from the spring's support. The spring exerts a restoring force, $F = -kx$, where x is the distance the spring is displaced from equilibrium and k is the force constant of the spring (also called the 'spring constant'). The negative sign indicates that the force points opposite to the direction of the displacement of the mass. The ratio of force to stretch is the spring constant, k.

For an object with mass, m, attached to a single spring, the theoretical period of oscillation is given by

$$T = 2\pi\sqrt{\frac{m}{k}} \tag{1}$$

where T is the time for one complete back-and-forth motion (i.e., one cycle), m is the mass of the object that is oscillating, and k is the spring constant.

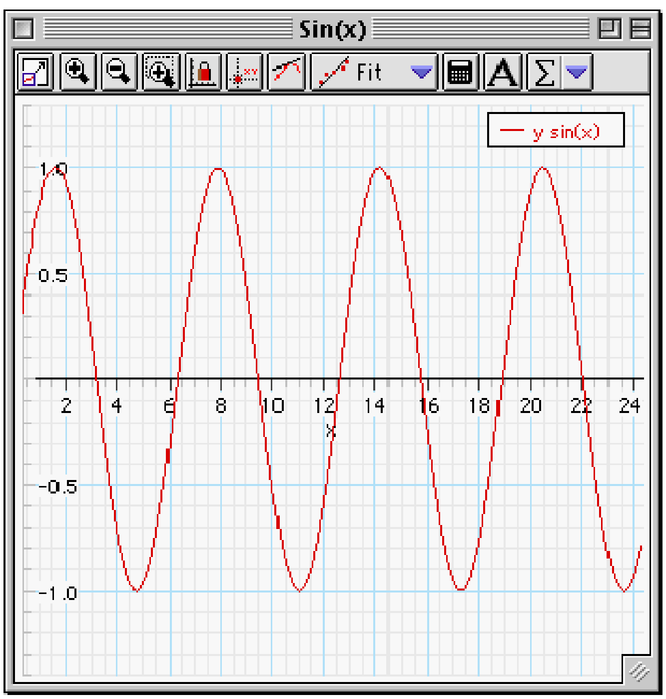

Figure 1

This activity uses two springs; one end of each spring is attached at each end of an object, and the other end of each spring is attached to fixed supports. For an object of mass m between two springs with spring constants k_1 and k_2, the period of oscillation is the following.

$$T = 2\pi\sqrt{\frac{m}{k_1 + k_2}} \tag{2}$$