

Hooke's Law: Springs and Karate Boards

Physics 110 Laboratory

Introduction:

In this experiment we will investigate the influence of variable forces. In particular, we first investigate the force that a spring exerts as it stretches more and more. We will then examine a force applied to a seemingly unspring-like object, a pine board, and measure its deformation to see if it behaves similarly to a spring.

Part I: Hooke's Law for Springs – a review

Theory:

According to Hooke's law the force that a spring exerts when it is stretched or compressed is directly proportional to the distance over which it is compressed or stretched. Although this "law" is often an idealization for most elastic media, it is conceptually very useful. This is because understanding this law allows for a simple approximation of most forces that change as a function of position.

Apparatus:

The experimental arrangement that we use in this lab is very simple. It consists of a spring (conical brass), assortment of hanging masses, clamps, and a ruler.

Procedure

Hang the spring vertically from a clamp. Attach different hanging masses to the free end of the spring and record both the value of the hanging mass and the distance that the spring stretches under the weight of the hanging mass. Repeat this for at least five different hanging masses. Please take care not to hang too heavy a mass to cause a permanent deformation of your spring.

Analysis

Plot the weight of the hanging mass versus the length that the spring stretches and from these data determine the force constant of the spring. Estimate the uncertainty in your measured and calculated values.

Part II: Karate Board: Does it act like a spring?

Theory:

When a force is applied to a pine board, it will be deformed. Does the deformation of the board vary linearly with the applied force, as it does for a spring? If Hooke's criteria can be reasonably applied to the pine board then we will estimate the speed with which we need to strike the board with our hand in order to break it. We will base this estimate on energy considerations.

Apparatus:

The experimental arrangement that we use in this lab is made of a cradle that hangs from a piece of board supported by an upside-down V-shape platform. Loading the platform with bricks, one at a time, increases the weight of the cradle. For each addition of a brick we determine the distance that the board bends using a position indicator dial-gauge. This gauge measures small changes in increments of 0.001 inches. (We load the cradle with enough bricks to ultimately break it.)

Procedure:

First measure the mass of six to seven bricks, one at a time, to obtain an average mass for one brick. Also, record the mass of the cradle.

Place a board horizontally on the two metal rods of the platform.

Mark the location of the tip of the dial touching the board using your pen and zero the dial.

Next hang the cradle from the board and record the dial.

Now add one brick at a time to the cradle and record the dial for each step. Continue until the board breaks! ***Please make sure to keep your toes and fingers away from the bottom of the cradle at all times!***

Analysis:

Plot the weight (F) versus distance (x). If the data approximates a straight line, fit the data and determine the effective spring constant of the board. What is the uncertainty in this value?

Calculate the work done on the board by the weights using your plot and a second time using the definition of work.

Estimate the weight of your fist (fully explain how you arrive at this value). From these values determine an approximate speed with which you need to strike the board with your fist in order to break the board.