611-1110 (40-220) Hooke's Law Apparatus

Warranty and Parts:

We replace all defective or missing parts free of charge. Additional parts may be ordered. We accept Master Card, Visa, American Express, and School P.O's. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear.

Description:

This lightweight, precise apparatus includes 50 g weights, weight hanger, and a movable millimeter scale. It can be used for accurate confirmation of Hooke's Law, in which the stretch of a body is seen to be directly proportional to its load. It can also be used to demonstrate harmonic motion by counting the oscillations per selected time period of a vibrating weight suspended from a spring.

Assembly Instructions:

Refer to Figure 1 below.

1. Slide the millimeter scale over the upright mounting post. Compress spring clip attached to scale. Scale can move to any desired position by compressing clip.
2. Attach mounting post to base. Threaded portion of post goes through the hole in base washer and wingnut affixes post to base. If base needs to be "screwed" into base, lock into place with the wingnut from above.
3. Attach one end of spring to post through small hole in post.
4. Slide pointer onto weight holder. Keep near top.
5 Attach weight holder to other end of spring which is hanging from post.

Definitions:

Hooke's Law, named after English physicist Robert Hooke, states: *The stretch of a body is directly proportional to the force that causes it if the stretching force is not too great.* That is, the strain of any force of unknown size (within the elastic limit, a concept discussed below) can be measured by measuring the strain it produced.

Directly proportional means one quantity is doubled by doubling a second quantity. If force **x** stretches a spring through distance **y**, a force of 2x will stretch it through distance 2y. This relationship is shown graphically by a straight line connecting points of data also passing through the origin.

Hooke's Law only applies to those circumstances in which a spring does not exceed its elastic limit. The elastic limit of a substance is the load per unit area beyond which the stretch is not proportional to the stretching force. When the elastic limit is exceeded, the substance is permanently stretched. (In the case of this apparatus, the weight limit of slotted weights and hanger is a maximum of 500 g.)

Adjustment:

For accurate and reproducible results, you need to adjust this apparatus. The indicator (pointer) should be brought as close to the scale as possible, with minimal distance between tip of pointer and physical location of the scale. Adjust pointer to a scale setting for zero which you have selected and recorded. Use mirrored strip on scale to judge exact location of the pointer by means of its reflection. To avoid parallax error, read the scale only when directly in front of and on the same eye level as the pointer.

Adjust by these methods:

1. Move and/or rotate pointer.
2. More/ rotate millimeter scale.

Caution: **1,000 grams will deflect the spring fully. Do not overload.**

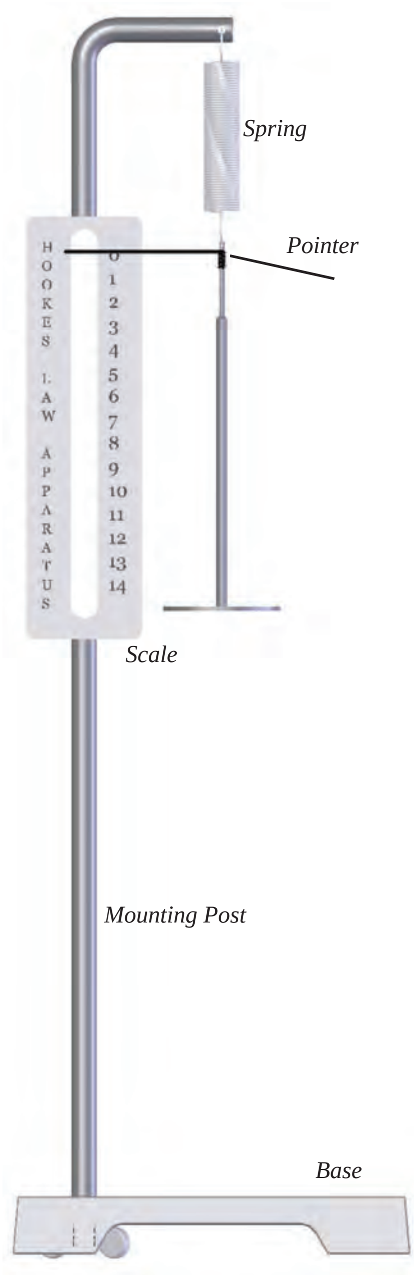

Figure 1: Parts

Hooke's Law Demonstration:

Caution: To avoid permanently deforming your spring, do not exceed 500 g total weight. Add slotted weights gradually in increments of 50 g or less.

Procedure:

1. Record the pointer's initial position. The coils of the spring should be slightly separated before taking your initial reading. Separation may be accomplished by preloading the spring with one weight. Included weights are slotted and must be slid over the top of the weight holder shaft.
2. Add a known weight to the hanger and record the deflection.
3. Continue to add known weights and record the deflections. Be careful that the applied weight does not extend the pointer beyond the upper limit of the scale. This will deform the spring.
4. Repeat Steps #1 - 3.
5. Graph the applied force (F) versus elongation of the spring (x). Each point represents the stretch in millimeters that a given load produced. Values of stretch (x) given along the vertical are ordinates of the graph. Values of load (F) along the horizontal are the abscissas. If all measurements are accurate, a straight line fits the point upon the graph up to but not exceeding the elastic limit.

F= force (total weight)
x = spring elongation

Slope of the line is K where: **F = KX**

This relationship holds true for all elastic displacements. With **40-220 Hooke's Law Apparatus**, it is difficult to exceed the elastic limit because the base provides a natural limit for the stretch of the spring.

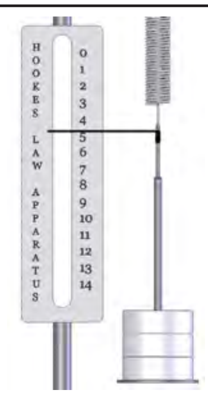

Fig 2: Deflection of spring

Harmonic Motion Demonstration:

In simple harmonic motion, it has been found that Hooke's Law holds at every stage of the movement of a taut, vibrating string. If you pull a taut string out of its equilibrium position, the amount of displacement from that equilibrium position is proportional to the force tending to restore it to that position.

If a string is released after being pulled, the restoring force accelerates it in the direction of the equilibrium position. As the string snaps back, it moves faster. Approaching equilibrium, its displacement from that position becomes continually less and the restoring force becomes less. Although the string moves more rapidly as a result, the rate of gain of velocity decreases. When equilibrium is reached, the string gains no more velocity. Its rate of motion is at a maximum.

In all cases of simple harmonic motion, it is crucial that the velocity changes smoothly at all times.

Procedure:

1. Attach known weight (i.e. 300 g)
2. Displace spring hanger 2-3 cm.
3. Release hanger
4. Count the number of oscillations per chosen time period (frequency).
5. Calculate the period of vibration using the formula $T = 2\pi\sqrt{M/K}$
   where:
   t = period (time)
   K = force constant of spring
   slope of graph
   M = mass of vibrating system

- The mass (M) of this system is the total weight suspended from the spring.
- In effect the period of simple harmonic motion depends only on the mass of the moving body and the proportionality constant between stress and strain. It allows accurate measurement of time merely by counting vibrations.

6. Repeat the above 5 steps with different weights and springs. Calculate the period of vibrations and compare to values obtained experimentally.

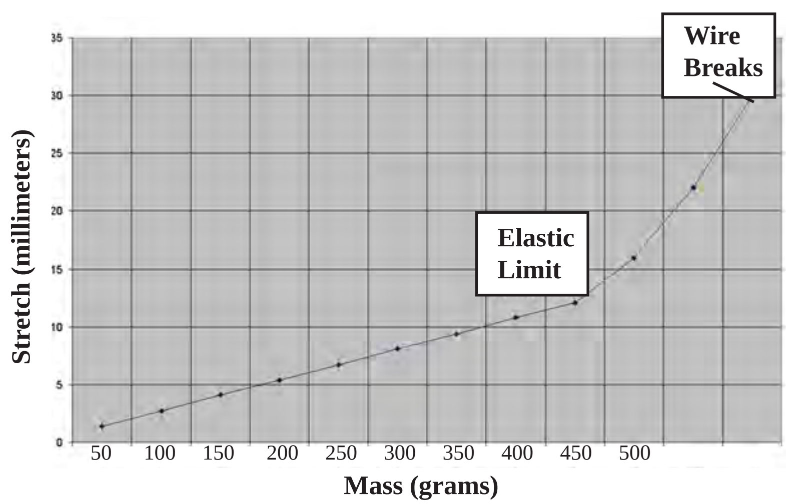

Fig 3: Example of a graphical depiction of Hooke's Law, readings may vary.

P/N 24-40220