

## Ut Tensio, Sic Vis Lab

### Teacher's Guide

**Topic:**

Newton's Laws of Motion

**The following information is provided to the student:**

**Question:**

What is the mathematical relationship (i.e., the equation) between the force applied to a spring and the amount of stretch of the spring?

**Purpose:**

To determine the mathematical relationship (i.e., the equation) between the force applied to a spring and the amount of stretch of the spring.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion of Results. The Data section should include the collected data listed in a row-column format; a plot of the amount of stretch versus the applied force should be sketched and the results of a linear regression analysis should be reported. The Conclusion/Discussion should identify some mathematical equation which relates the two quantities under study. The historical significance of the title of the lab should be discussed (a simple Googling should help) and related to this lab. The meaning of any constants in the equation should also be discussed.

**Materials Required:**

Spring; metric ruler; lab poles and clamps; hooked mass set.

**Description of Procedure:**

A spring is mounted and hung vertically from a clamp. The length of the spring (from one end to the other) is measured. A mass is hung from the spring and its new length is measured. The amount of stretch is calculated. This process is repeated for varying amounts of mass. The applied force is equal to the weight of the hanging mass. A plot of applied force and stretch distance is constructed. Linear regression analysis is performed to determine the equation relating the two quantities.

**Alternative Materials and Procedure:**

The spring system could be mounted horizontally (attached to a pole) and a force scale or a computer interfaced force probe could be used to determine the force-displacement relationship. The strategic placement of a meter stick parallel to the spring allows for quick readings of the displacement for each corresponding force.

**Safety Concern:**

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated.

**Suggestions, Precautions, Notes:**

## The Laboratory

1. The title is from Latin, meaning “As the extension, so the force.” Robert Hooke originally published the scientific law relating the force to the displacement of a spring using a Latin anagram. (See [Wikipedia](#) for an interesting discussion of the history.)
2. Emphasize to students that springs can be ruined by exertion of too much force. Provide limits and prevent student *horseplay*.
3. As an extension, students could repeat the procedure with a different spring. The constant of proportionality (spring constant) will vary from spring to spring.

### Auxiliary Materials:

None

### Scoring Rubric:

<b>NL12. Ut Tensio, Sic Vis Lab</b>	<b>Score</b>
— Included, labeled and organized all parts of the lab report. — Data section includes collected data organized in a row-column format; units and column headings are indicated. A sketch of the plotted data is provided and the results of the linear regression analysis (slope, y-intercept and regression constant) are reported. — Conclusion/Discussion identifies the mathematical equation relating the stretch distance and the applied force; symbols in the equation are defined. The meaning of the Ut tensio, sic vis title is discussed and related to the lab findings. The meaning of the numerical constant in the equation should be discussed.	____/____

### Connections to The Physics Classroom Tutorial:

This lab is a suitable accompaniment to the reading at:

<http://www.physicsclassroom.com/Class/newtlaws/u2l2b.cfm>

### Connections to Minds on Physics Internet Modules:

This lab is not ideally coordinated with any of the sublevels of the Minds On Physics Internet Modules.