

## Maximum Load Lab

### Teacher's Guide

**Topic:**

Vectors and Forces

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

**Question:**

What is the maximum load which a light string can support when assuming a v-shaped orientation and supported on its ends at two points? How does the measured value compare to the predicted value?

**Purpose:**

To determine the maximum load which a light string could support when assuming a v-shaped orientation and supported on its ends at two fixed points and to compare the maximum value to the predicted value based on the string's breaking strength.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion of Results. Data section should include a diagram of the experimental setup and a representation of how the measurements of maximum load was determined. Results of several trials are documented and an average value is determined; outliers are indicated. Calculations of the theoretically predicted value is included; analysis is thoroughly documented beginning with a *force triangle*. The Conclusion/Discussion answers the question posed in the Purpose. An error analysis along with a percent difference calculation is included in the discussion.

**Materials Required:**

Spool of light string (or thread); protractor; spring scale or computer-interfaced force probe; two hooks from which to suspend the string.

**Description of Procedure:**

Students are given the same string used in the Breaking Strength Lab in the Newton's Laws unit. The string is hung from two vertical supports, so as to create a v-shaped orientation (roughly). Students devise a means of exerting a force at the mid-point of the string in order to determine the maximum force which the string can withstand before breaking.

**Alternative Materials and Procedure:**

Lab poles and clamps could be used to provide supports from which to suspend the string.

**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 breaking strength of the string was measured in the Breaking Strength Lab during the Newton's Laws unit. Students should use string from the same spool that was used during that lab.
2. The computer-interfaced force probe is the ideal tool for measuring the maximum load of the string. Software accompanying the probes typically keeps track of the amount of force over the course of time. The moment the string breaks, the tension reduces to zero. The force reported by the computer just prior to this event is the maximum load.
3. Leaving the procedure open-ended makes this activity into an exceptional problem-solving activity. Students are left to devise their own means by which to measure the maximum load.
4. A commonly used method involves pulling downward upon the string at its midpoint using the computer interfaced force probe. Trials are repeated for the same length of string and the same angle. An average value is determined from all the measurements.

### Auxiliary Materials:

None

### Scoring Rubric:

<b>VF4. Maximum Load Lab</b>	<b>Score</b>
— Included, labeled and organized all parts of the lab report. — Data section includes an informative diagram of the experimental setup; method of measurement is indicated. Data for several trials are organized; unit is stated; outliers are indicated and an average maximum load is calculated. Theoretical analysis based on the breaking strength is presented in an organized fashion, beginning with a <i>force triangle</i> . — Conclusion/Discussion answers the <i>question</i> posed in the Purpose. An error analysis is included; the reliability of the results are evaluated; a percent difference calculation is performed and discussed; work is shown.	____/____

### Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/vectors/u3l3b.cfm>

<http://www.physicsclassroom.com/Class/vectors/u3l3c.cfm>

### Connections to Minds on Physics Internet Modules:

Sublevels 3 and 4 of the Forces in Two Dimensions module are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/mop/module.cfm>