

## Getting Hung Up by Tension Lab

### Teacher's Guide

**Topic:**

Vectors and Forces

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

**Question:**

What is the result of conducting a force analysis on an object at equilibrium?

**Purpose:**

To conduct three different equilibrium analyses in order to determine the net force upon three different objects.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion of Results. The Data section should include a diagram of the three situations being analyzed with the magnitude and direction of all forces clearly stated on the diagram; a labeling convention (e.g.,  $A=$  ,  $B=$  ,  $C=$  , etc.) should be used to distinguish between the forces. Calculations and analysis should be clearly shown. A net force should be determined. The Conclusion/Discussion should identify the calculated net force for the three situations and should include an error analysis for each situation.

**Materials Required:**

Force scales; hooked masses; force table; force boards; ropes; strings; C-clamps; lab poles; coffee mug hooks; protractors; etc.

**Description of Procedure:**

The class is presented with three different equilibrium situations. The magnitude and direction of the forces are measured and organized in a data table or on a diagram. Trigonometric functions are used to resolve each force into components. The net force is determined by component analysis.

**Alternative Materials and Procedure:**

A multitude of different equilibrium situations could be created; a force table or force board is not necessary. A hooked mass could be hung on a string which is secured to two hooks in a cabinet; force scales could be arranged to determine the tension in the string. Three ropes could be tied together at a point and secured to a table or lab bench using C-clamps; force scales could be arranged to determine the tension in each string. A hooked mass could be suspended from two strings, each of which make a different angle with the horizontal; force scales could be arranged to determine the tension in each 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. This lab makes for a great stations activity. Several equilibrium arrangements can be set up throughout the room. Organize students in lab groups and allow them to migrate from station to station to make measurements.
2. This activity provides students with a challenge of organizing and documenting their work - a critical skill for scientists and members of all professions.

### Auxiliary Materials:

None

### Scoring Rubric:

<b>VF2. Getting Hung Up by Tension Lab</b>	<b>Score</b>
____ Included, labeled and organized all parts of the lab report. ____ Data section includes a diagram for the three situations; forces are clearly labeled with a magnitude (unit included) and a direction. A labeling convention is used. Calculations and analysis is clearly documented. Analysis is error-free and leads to a reasonable result for the $F_{\text{net}}$ value. ____ Conclusion/Discussion identifies the net force for each of the three situations and includes a thorough error analysis. Discussion and preceding analysis reveals a solid understanding of equilibrium and its mathematics.	____/____

### 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>