

## Modified Atwood's Machine Lab

### Teacher's Guide

**Topic:**

Vectors and Forces

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

**Question:**

What is the mathematical equation relating the final velocity (after accelerating 1.00 m from rest) of a low-friction cart (or air track glider) to the amount of hanging mass on a modified Atwood's machine?

**Purpose:**

To experimentally derive an equation relating the final velocity (after accelerating 1.00 m from rest) of a low-friction cart (or air track glider) to the amount of hanging mass for a modified Atwood's machine.

A complete lab write-up includes a Title, a Purpose, a Data section, a Conclusion and a Discussion of Results. Data section should include a data table with several trials for varying mass (hanging) and the corresponding values for the final velocity. The results of a power or linear regression analysis should be conducted and statistical information reported. The development of the equation should be well-documented. The Conclusion should (as always) respond to the question raised in the Purpose. The Discussion of Results should include an error analysis. As part of the analysis, theoretical considerations (free-body diagram, Newton's laws analysis, kinematics) which could provide a prediction of the mathematical equation should be discussed. The equation reported in the Conclusion section should be compared to a theoretically-derived equation.

**Materials Required:**

Track; cart; computer interfaced motion detectors; pulley; hanging mass set; light string or thread.

**Description of Procedure:**

A cart is equipped with a hook (e.g., paper clip) and placed upon the track. A low-friction pulley is connected to one end of the track. A 10-gram mass is suspended from the end of a string. The string is stretched over the pulley and connected to the hook on the cart. A motion detector is positioned behind the cart in order to detect the motion of the cart. After all parts of the experiment are set up, the cart is released and the hanging mass accelerates the cart along the track. The motion detector is used to determine the velocity of the cart after it has moved 1 meter. Trials are repeated for several different hanging mass amounts. The data is analyzed to determine an equation between the mass and the final of the cart velocity (after traveling 1.00 meter).

**Alternative Materials and Procedure:**

Air tracks and air track gliders could be used in place of a track and cart. A photogate system could be used in place of a motion detector.

**Safety Concern:**

## The Laboratory

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:

1. Most computer interfacing equipment is accompanied by software which allows the user to zero a force probe and/or a motion detector. Since this lab involves determining the velocity of the cart after traveling 1.00 m, it is advised that the motion detector be zeroed just prior to being released. Doing so will make the initial position of the cart equal to 0 m and will make the task of determining the velocity after 1.00 m of distance much easier.
2. It is important that the mass of the hanging mass be small in comparison to the mass of the cart. Using hanging masses of 10 g, 20 g, 30 g, 40 g, etc. for a cart mass of 1000 g should suffice. If this condition is met, there will be a greater correlation between the equation generated from a power regression analysis.

### Auxiliary Materials:

None

### Scoring Rubric:

<b>VF8. Modified Atwood's Machine Lab</b>	<b>Score</b>
— Included, labeled and organized all parts of the lab report. — Data section includes a table of collected data with column headings and indicated unit. The results of a power or a linear regression analysis is provided; sketch of plotted quantities, statistics and equation are reported. Data is reasonable and analysis is accurate and well-documented. — Conclusion states the equation derived from the data; symbols are defined. — Discussion of Results provides a reasonable and organized derivation of a theoretical equation relating $v_f$ and $m$ . Derivation is clear, labeled and thorough; included accurate FBD, a Newton's laws analysis and use of a kinematic equation. Reveals a high level of understanding.	—/—

### Connections to The Physics Classroom Tutorial:

This lab is a suitable accompaniment to the reading at:

Readings on Two Body situations are not currently available.

### Connections to Minds on Physics Internet Modules:

There are no sublevels of Minds On Physics which pertain to two-body problems.