

## From a Feather to an Elephant

### Teacher's Guide

**Topic:**

Newton's Laws of Motion

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

**Question:**

What effect does varying mass have upon the terminal velocity value of an object which is falling under the dual influence of gravity and air resistance?

**Purpose:**

To describe the effect of varying mass upon the ultimate terminal velocity value of an object which is falling under the dual influence of gravity and air resistance.

A complete lab write-up includes a Title, a Purpose, a Data section, a Conclusion/Discussion of Results. The Data section should include velocity-time graphs for several trials of varying number of filters. Relative values of the terminal velocity should somehow be indicated for the various numbers of filters so as to make a conclusion possible. The Conclusion/Discussion should reference the data to describe how varying mass effected the terminal velocity value (provided such a conclusion can be supported by the data).

**Materials Required:**

Several coffee filters; computer-interfaced motion detector; mass balance

**Description of Procedure:**

Students drop a coffee filter and use a motion detector to determine the final velocity of the filter as it hits the floor. Additional trials are performed using two, three, four, ... filters stacked together.

**Alternative Materials and Procedure:**

A stopwatch and a meter stick can be used in place of the motion detectors. An average velocity value can be obtained in place of a terminal velocity value. Trials should be repeated to insure the most accurate results. If mass balances are not abundantly available, then the mass of a single filter can be determined and provided to students. This value can be used to determine the mass of a stack any quantity of filters.

**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. Extreme caution should be taken if students are leaning over stairwell railings or out over the edge of lab tables in order to drop coffee filters or hold motion detectors. Monitor student behavior closely and intervene when safety appears to be forgotten.

**Suggestions, Precautions, Notes:**

## The Laboratory

1. By massing 10 filters on a mass balance, students can obtain the mass of a single filter. This mass can be used to determine the mass of a stack any quantity of filters.
2. It is instructive to discuss the fact that the final velocity of the filters when they strike the floor is not necessarily the **terminal velocity** of the filter. The terminal velocity of the filters is the velocity which the filters have when it has ceased its acceleration (or after it has *approached zero*). Spend some time discussing with the class that if there was a greater falling distance, this terminal velocity value could be determined using the same method used in this lab. And it would likely be the case that any stack of filters which struck the floor with a greater final velocity value would also have a greater terminal velocity value if given the needed falling distance to reach it.
3. The use of a laptop computer or the portable interface devices (such as Vernier's LabQuest or Pasco's Spark) allows a class to conduct trials in a stairwell. This makes for a useful teacher demonstration.

### Auxiliary Materials:

None

### Scoring Rubric:

<b>NL6. From a Feather to an Elephant Lab</b>	<b>Score</b>
— Included, labeled and organized all parts of the lab report. — Data section includes terminal velocity information for the various trials - either as velocity-time graphs or actual readings from such graphs; axes are labeled; units are indicated, results are organized and clearly recorded. — Conclusion/Discussion describes the effect of varying mass on the terminal velocity. Actual data which support such a conclusion are referenced and explained.	____/____

### Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/newtlaws/u2l3e.cfm>

### Connections to Minds on Physics Internet Modules:

Sublevel 10 of the Newton's Law module is a suitable accompaniment to this lab:

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