[](http://www.google.ca/imgres?q=basket+filters&um=1&hl=en&safe=active&sa=N&biw=1680&bih=836&tbm=isch&tbnid=o8D_1p9FCfrLqM:&imgrefurl=http://www.bizrate.com/coffee-maker-accessories/289242868.html&docid=qoIUQmMjMJPscM&imgurl=http://images.bizrate.com/resize?sq=475&uid=289242868&w=475&h=475&ei=80-YTuiMJYLo0QHro_SxBA&zoom=1&iact=rc&dur=390&sig=114135713869694269104&page=5&tbnh=145&tbnw=207&start=142&ndsp=36&ved=1t:429,r:14,s:142&tx=120&ty=58)SPH4U0 Investigation: Terminal Velocity and Mass Name:\_\_\_\_\_\_\_\_\_\_\_\_ \_

**Purpose**: In this experiment, you will be investigating how terminal velocity

of an object depends upon mass.

**Lab Overview:**

Terminal velocity is the final velocity reached by an object accelerating through a fluid such as air or water, when the upward resistive force due to air resistance or water drag grows to balance the downward force of gravity on the object. When the forces on the falling object become balanced, it stops accelerating and begins falling at a constant velocity referred to as the terminal velocity.

The terminal velocity reached by a given object depends upon a number of factors: the mass of the object, the acceleration due to gravity (g), the density (ρ) of the medium in which it is falling, the area of the object (A) and a drag coefficient (C) dependent upon the shape of the falling object.

In this lab, we will investigate how terminal velocity depends upon mass. In order to isolate this relationship, we will need to keep the other factors affecting terminal velocity (acceleration due to gravity, density of medium, area of object, drag coefficient) constant. We will achieve this by using coffee filters as our falling object! Coffee filters are low in density and are easily stacked to preserve the same overall shape thus keeping the drag coefficient and area constant while allowing us to vary the mass.

**Hypothesis:** Through research or other means, prepare a hypothesis for the predicted relationship between the terminal velocity and mass. Only a general hypothesis is required; for example, you may predict that terminal velocity depends linearly on mass (Vtα m) or that the relationship is a power relationship (Vtα m2), etc. Make sure to reference any sources you use in your research.

**Materials**: Pasco Interface and motion sensor, metre stick, coffee filter stack (10 filters), electronic balance

**Procedure:**

1. Log in to a computer and select the Data Studio icon from the applications.
2. Connect a motion sensor to the interface hub.
3. Follow the instructions on the Pasco Probes Installing Drivers handout to install the required driver for the Pasco interface.
4. Once the drivers are installed, open the following file:

I:\4Students\OUT\Ryan\pasco probes\grade 12\terminal velocity.ds

1. Set up a data table to record your values. The table should include space for the number of filters dropped, two velocity trials and the average velocity. Record an appropriate uncertainty for the velocity at the top of your table.
2. Measure the mass of the stack of coffee filters using the electronic balance.
3. Drop the filters from a height of approximately 2.0 m. This can be achieved by placing the motion sensor on the floor by the edge of the lab bench and using the metre stick to mark a position approximately 1.0 m above the lab bench surface. The exact height of release is not critical-the distance only has to be high enough so that the filters reach a constant velocity as they fall.
4. Begin by dropping 10 filters. Have one partner hit “Start Collection” while a second partner releases the stack of filters. The other partners should observe the stack drop to ensure that the stack remains aligned with the motion sensor as it drops. If the stack goes off course, that trial should be repeated.
5. Once a good trial is achieved, determine the terminal velocity by taking the slope of the d-t graph. Record this value in a table and then repeat the experiment for the same number of coffee filters so that two trials have been recorded.
6. Repeat steps 6 through 8 after removing one coffee filter each time.

**Analysis and Discussion:**

1. Find the average velocity for each trial. Keep 2 decimal places in your average velocity values.
2. Prepare a graph of terminal velocity versus mass. Describe the shape of this graph and the general relationship that is illustrated by the shape of the graph.
3. Using graphical analysis techniques, verity the relationship between velocity and mass. Calculate the proportionality constant for the relationship (V= kf(m)).

**In your formal report, make sure to describe your analysis steps and show appropriate sample calculations. All tables and graphs should be introduced and explained!**

**Refer to the Laboratory Investigation Report format posted on the course website for a model of a formal lab report.**

**Conclusion**:

Discuss the analysis and refer back to your initial hypothesis. Was your hypothesis correct?

Discuss whether you felt this was a reasonable procedure by which to investigate terminal velocity. Were there any challenges that made this lab difficult to perform? How could you modify the experiment if given the chance to perform it again?

Extension: Describe another experiment in which you would be interested in using this technique of measuring terminal velocity. Think of a situation in which the terminal velocity of an object is important.

**Write-Up**

Prepare a full lab write up according to the general guidelines. The lab will be submitted through TurnItIn.com.

You will be given a mark for your lab book in addition to the report. For this lab, our lab book should include:

**Title and Group Members, Date**

**Purpose statement**

**Hypothesis**

**Materials**

**Procedure: Modifications or important points about procedural steps.**

**Sketch of the experimental set-up (you may also take a picture to include in the report)**

**Observations**

**Analysis Tables**

**For this lab, graphs should be done by hand.**