Coffee Filter Lab

As objects fall, they increase their speed due to the downward pull of gravity. Air resistance counteracts gravity's pull by resisting the downward motion of the object. The amount of air resistance depends upon a variety of factors, most noticeably, the object's speed. As objects move faster, they encounter more air resistance. When the amount of upward air resistance force is equal to the downward gravity force, the object encounters a balance of forces and is said to have reached a **terminal velocity**. The terminal velocity value is the final, constant velocity value achieved by the falling object.

Figure 1

A group of physics students are investigating the terminal velocity values obtained by falling coffee filters. They videotape the falling filters and use *video analysis software* to analyze the motion. The video is imported into the software program and the filter's position in each consecutive frame is clicked on (see **Figure 1**). The software uses the position coordinates to generate a plot of the vertical velocity as a function of time. **Figure 2** shows the velocity versus time graph that resulted from the analysis of the motion of a single filter.

The lab group then investigated the effect of mass on the motion of the falling filters. They stacked varying numbers of pleated coffee filters tightly together and analyzed the motion of the stacks of filters. They determined the terminal velocity of the stacks of filters. The students also measured the mass of the filters to determine their weight and used the value to determine the amount of air resistance encountered by the filters. The results of several trials are shown in **Table 1**. The terminal speed (i.e., velocity) as a function of mass is shown in **Figure 3**.

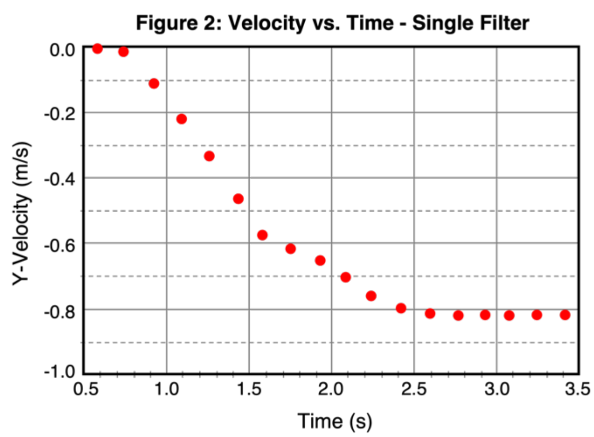

Table 1

Trial	# of Filters	Mass (g)	$v_{terminal}$ (m/s)	Resistance (N)
1	1	0.99	0.87	0.0097
2	2	1.99	1.24	0.0195
3	3	3.01	1.52	0.0295
4	4	4.00	1.75	0.0392
5	5	5.00	1.90	0.0490
6	8	7.99	2.41	0.0783
7	10	10.01	2.55	0.0981