Lab 2, Part 2: How can information about forces be derived from a video? Error Propagation and Analysis of Directed Motion & Resistive Forces

This is the second week of a two-week lab sequence designed to introduce you to error propagation and analysis of directed motion and resistive forces. In the first week, you collected video data using ImageJ for two separate investigations. In the first investigation, you gathered data investigating how resistive forces and terminal velocity scale with the mass of the falling object. In the second investigation, you gathered data investigating how resistive forces and terminal velocity scale with the viscosity of the fluid. This week you will analyze your data and try to determine how the terminal velocities scale with respect to the varied quantities. The lab handout will give explicit instructions on error propagation, but no guidance in the performance of the physics skill goals.

Below, you will find information about the viscosities of the percent solutions that you worked with last week. Other possibly helpful information is available from your TA—if there is information (physical data) that you think you will need, don't hesitate to ask—but you have to know what you are asking for!

At the end of the lab today, **your group will submit one lab report**. This will be reviewed by the TA according to the Scientific Community Lab rubric. Good attention to detail now will save you time later! Remember, your TA is here to help you with equipment, error propagation, and ImageJ, but the physics is up to you and your group!

Approximate Timing: (~2 hours)

- Introduction: 10 minutes
- Data Analysis (1st investigation): 30 minutes
- Data Analysis (2nd investigation): 30 minutes
- Class Discussion/Summation: 10 minutes
- Finalize Report: 30 minutes

Physics Skill Goals:

- Analyze 1-D motion from a video/image sequence
- Tabulate the position-at-time for an object's motion
- Calculate average speed
- Understand the concept of terminal velocity
- Understand the scaling of terminal velocity with mass
- Understand the scaling of terminal velocity with dynamic viscosity
- Understand the types of resistive force in 'fluids'—Drag vs. Viscous resistance
- Analyze motion graphs (y vs. t, v vs. t)
- Determine uncertainty in video measurement

Viscosities: (Are there other pieces of information you think you need? Decide and then ask for it!)

Percent Glycerol (by Volume)	0%	30%	40%	50%	60%	70%	80%
Dynamic Viscosity (Ns/m^2)	0.0009	0.0026	0.0041	0.0070	0.0132	0.0278	0.0435

Things you might consider including in your report: (These are not necessarily required. You and your group should consider what INFORMATION is necessary to SUPPORT the CLAIMS that you are making!)

- Plots of y vs. t OR v vs. t for each video (Do you need both plots for each video?).
- Data table for terminal velocity, terminal velocity squared, and m for investigation #1.
- Data table for terminal velocity and viscosity for investigation #2.
- Plots of terminal velocity vs. mass and terminal velocity squared vs. mass with error bars. (Do you need both graphs?)
- Plot of terminal velocity vs. viscosity with error bars.
- Consider discussing the following questions:
    - What is the terminal velocity for each video? How certain is this value?
    - How do the different terminal velocities for each investigation fit together to describe the resistive force?
    - For the 2nd investigation, how does terminal velocity scale with viscosity?