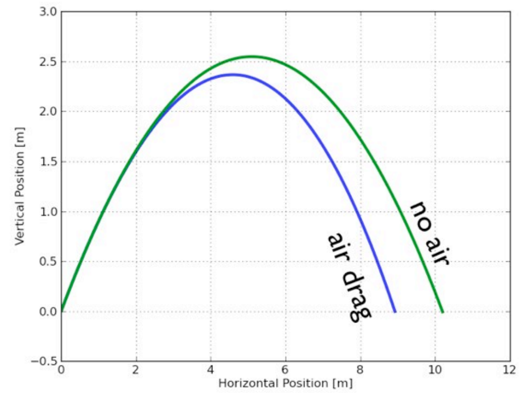
PS 12a Names:

Lab 9: Projectile Motion Simulator

In this lab you will do some experimental exploration of a projectile launcher. You will compare motion data that you collect in lab to a projectile simulator containing your model predictions. We are interested in the motion of a Styrofoam ball that is shot from a spring launcher. Air drag will definitely be a factor Specifically we would like to know how air drag changes the flight path.



Warm Up: Track the Motion of the Projectile

On the computer is a 120 frame per second film of Styrofoam ball being shot from your launcher. Track the motion of the ball in Logger Pro and prepare the data for export. Pay special attention to

- Add a known distance measure. Use the meter stick in the video.
- Set up a coordinate system that simplifies the situation
- Set the frame rate of the video (Double click on the video and override the original frame rate with 120fps
- Increase the precision of the exported data. Double click on one of the Logger Pro data headers. Choose 'options' and increase the sig-figs to the highest allowable. Repeat this for other data columns of interest.
- Make note of any data points you may want to trim later

1. Export the video data as a .csv file and load into matlab. Use the variable names t, x, y, vx, and vy. Save your workspace.

2. We have provided a script to help analyze the data. Load the script lab9_template.m

3. Take a few minutes to read through the script. Make any immediate changes that you notice to get the script working.

Q1. What are the three plots being plotted and overlaid? Should the data fall below the other plots or above? What changes did you make to get things into agreement?

Q2. Describe how the script is calculating the launch angle and initial speed. Make note of the code line #'s that do this. (Hint: help polyfit).

Linear Drag Model 1:

Modify the script so that the numerical plot now follows a path that accounts for linear drag.

Q4. What changes did you make to the code? Did you introduce any new physical parameters?

Tweak the parameters to get the best fit possible. You might even tweak the calculated theta and v0.

Q5. What where your parameters that got the best fit?

Drag coefficient b1=	kg/s
v0=	m/s
theta=	degrees

Quadratic Drag Model 2:

Now add a section to the script that will create a figure 3 that plots the data (blue), analytical solution (cyan) and the quadratic drag model (green).

Tweak the parameters to get the best fit possible.

Q6. What where your parameters that got the best fit?

Drag coefficient b2=	kg/m
v0=	m/s
theta=	degrees

Q7. Are there other effects that should be taken into account? What are these and how would you account for this?

Challenge:

Place a target at some unknown distance from your table. Use your simulator to calculate the angle that you should shoot the foam ball to come closest to the target in one shot. Take a shot.