



Part 2: Projectile Launcher Analysis Report

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Due Dec 17, 2015 by 10:30am **Points** 100 **Submitting** a file upload
Available after Dec 17, 2015 at 6am

Step 2 - Now We Look At The Real World

In the second phase of the Fall Final, you are going to use the high speed video footage captured during your device's launch in order to see how your device *actually* performed.

Your Data:

You are going to need to access the video that was taken of your device - it can be accessed here:

[2015 Projectile Launch](https://drive.google.com/folderview?id=0B4uSB003seEURkhaQ3Fkc3lwM28&usp=sharing) (<https://drive.google.com/folderview?id=0B4uSB003seEURkhaQ3Fkc3lwM28&usp=sharing>)

Procedure for Tracking Motion:

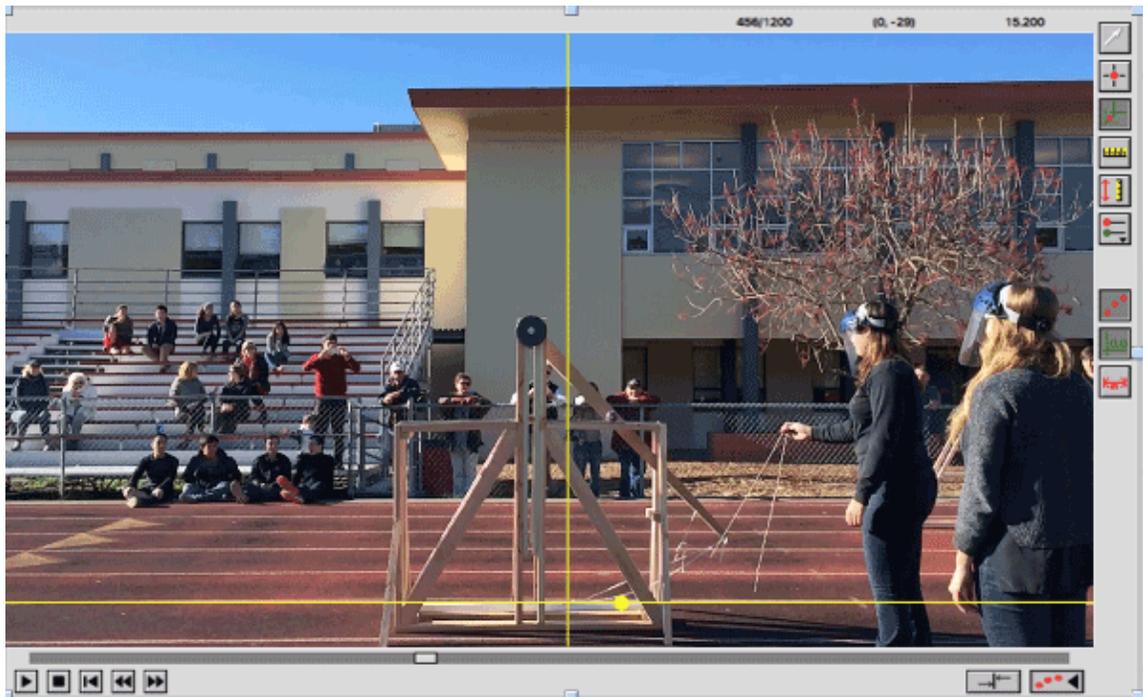
Now that you have your video, you are going to use Logger Pro to help you analyze the video. To do so, you first have to tell Logger Pro *frame by frame* what it is that you want to actually track. You have done this before (twice actually), but I have provided a brief review of the video analysis tools window:



You are currently logged into
Student View

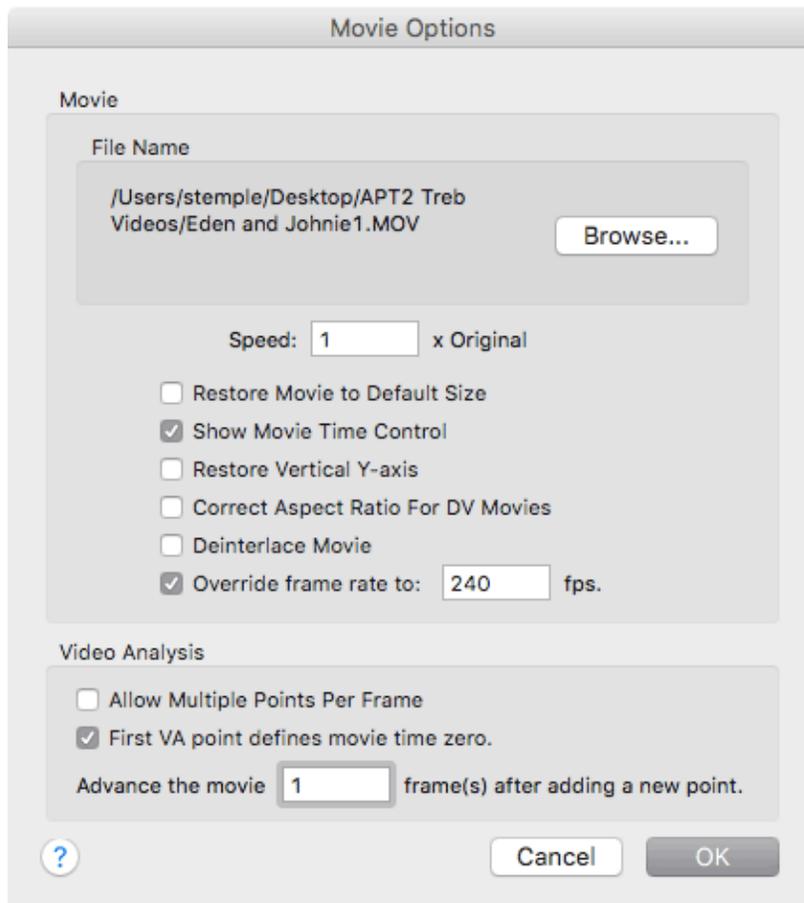
Resetting the test student will clear all history for this student, allowing you to view the course as a brand new student.

[Reset Student](#)[Leave Student View](#)



Please refer to it for the following instructions:

1. Download your movie to your computer.
2. Start Logger Pro. Choose **Movie** from the **Insert** menu. Find and insert your movie.
3. Go to the **Options** menu and select **Movie Options**. Enter in the following information so that LoggerPro understands the video frame rate:



4. Now **Enable Video Analysis** by clicking on the button in the lower-right corner of the movie window. This brings up a toolbar with a number of buttons (see above).

5. Click the **Set Origin** button (third from top), then click in the movie frame to set the location of the origin. Please choose the origin point as the point where the projectile starts (see above).
6. Click the **Set Scale** button (fourth from top), then drag across an object of known length in the movie. When you release the mouse button, enter the length of the object; be sure the units are correct.
7. Use the forward button to advance the movie until the ball begins to move.
8. Now click the **Add Point** button (second from the top). Important: Be consistent in your marking. Each time you mark the object's location, the movie advances one frame. You may choose to mark the position every few frames at the beginning because its rather slow, but as the ball begins to pick up speed, you can mark it every frame. Notice that data points are being plotted on the graph.
9. Continue this process until you see the ball released from the sling. You might want to mark the ball a few frames after release too. *Should you wish to edit a point, click the Select Point button (top)*. This allows you to move or delete a mistakenly marked point.
10. Select the graph window. Logger Pro defaults to display both the x and y positions of the object as a function of time. You can double click the graph area and choose to view different columns on different axes.

The Analysis:

You are first going to use LoggerPro to do some further analysis on the projectile, and then you are going to use this data to answer some questions.

Determining the Launch Velocity:

You might recall that LoggerPro allows you to add calculated columns to your data set. I would like you to create a new Calculated Column (go to the **Data** menu and choose **New Calculated Column...**) with these settings:

Calculated Column Options

Column Definition Options

Labels and Units

Name: Velocity (x and y) * ▾

Short Name: V * ▾ Units: m/s * ▾

Destination

▾ Add to All Similar Data Sets

Expression

(("X Velocity")^2 + ("Y Velocity")^2)^.5

Functions ▾ Variables (Columns) ▾ Parameters ▾

? Cancel Done

The expression for the velocity is:

$$v = \sqrt{(v_x)^2 + (v_y)^2}$$

This column should give you the value of the *speed* of the projectile - or the combined velocity in both dimensions - which is what you will need to calculate the kinetic energy of the projectile.

Determining the Launch Angle (AP Only!):

I would like all the AP students to also create another column for determining the angle of motion. Please create a new Calculated Column (go to the **Data** menu and choose **New Calculated Column...**) with these settings:

Calculated Column Options

Column Definition Options

Labels and Units

Name: * ▾

Short Name: * ▾ Units: * ▾

Destination

▾ Add to All Similar Data Sets

Expression

▾
 ▾
 ▾

The "expression" has been left blank because I want you to figure it out! Here are some hints. The function **atan** is the inverse tangent function, and it is one of the built in **Functions** in LoggerPro. These built in functions return angle values in radians, but I want the values in degrees. Remember that you can convert those values by using a conversion factor of π radians = 180 degrees, or:

$$\text{radians} * (\pi/180) = \text{angle in degrees}$$

Submit Your File

I would like you to submit your LoggerPro file - so please name it - "*Your Name - Fall 2015 Final*", and submit it to this Canvas assignment.

Calculations:

On a separate piece of paper, you will need create an analysis report. The analysis report must contain the following information:

1. The kinetic energy of the projectile at the point it leaves the sling.
2. The amount of gravitational energy "lost" by the counterweight/gravitational field system once the weight drops to its lowest vertical position.
3. The energy efficiency of the device, which is calculated by dividing the kinetic energy of the projectile by the change in gravitational energy and then multiplying that by 100%:

$$\left(\frac{\Delta E_k}{\Delta E_g} \right) \cdot 100\%$$

4. AP ONLY: Please calculate the IDEAL horizontal range of your projectile based on the launch velocity, launch height and launch angle. Assume that the landing point is at the same elevation as the starting point of the projectile when it was in the loaded position. Yes, that means that the landing point and launching point are at different y positions!

With these calculations, please proceed to the analysis questions.