Physics Lab 4: Analyzing Motion

➢ **Leave space in your notebook for printouts of the graphs you will obtain in this investigation.**
➢ **If you use someone else's data, you must make sure to note that and credit those investigators in your lab notebook.**

Goals: Improve your ability to use LoggerPro software to analyze kinematics data; Gain more experience with graphical representations of motion; Analyze data for constant acceleration situations.

Reference for today's activity: LoggerPro tutorials 09 Curve Fitting, found through LoggerPro, File: Open: Tutorials.

Bouncing Ball
a) In Physics Lab 3, you used a Motion Detector to measure the position vs. time for a ball bouncing straight up and down vertically. If you weren't present in that lab or didn't obtain good data, consult with a classmate to see if you can obtain that data. You want good data that shows the position vs. time for several bounces. Open that saved file and **save it to your cubbie**.
b) Identify the first bounce for which the position vs. time data is smooth and clean. Zoom in on the graph so that just that single bounce fills the graph horizontally and vertically.
c) The corresponding velocity vs. time graph should automatically have rescaled on the horizontal (time) axis. Zoom in the vertical axis so that the velocity data fills the graph vertically. Note: the position vs. time data should be pretty smooth even at the bounces with the floor, but the velocity vs. time data is not as good at the bounces with the floor. This is because LoggerPro is calculating the velocity from the position, whereas we measure the position vs. time data; the sudden changes at the bounce make the calculation difficult.
d) Find the time when the ball is at its maximum height. At that time, what is the ball's velocity?
e) Use your mouse and click and drag to highlight a portion of the velocity vs. time graph. Highlight roughly 0.1 s before the zero crossing through roughly 0.1 s after. Does this region look linear? If there is a slightly larger time domain for which the data is clearly linear, highlight that, taking care to ensure that the zero crossing is roughly in the center of your highlighted region. Obtain a Linear Fit to the data in the highlighted region, either by using the button on the toolbar or through Analyze: Linear Fit. Examine the best fit line that LoggerPro generates to confirm that this model fit represents your data well. If not, reduce the domain of the highlighted region.
f) Record the slope (include sign and units as well as the numerical value), along with the RMSE value.
g) When you highlighted the velocity vs. time data, the corresponding section of the position vs. time graph should also have been highlighted (or close to it). If not, highlight the position vs. time data in a symmetric region centered on the maximum height.
h) Hopefully, you are familiar by now with the idea that a linear velocity vs. time graph corresponds to a quadratic position vs. time graph. Obtain the best fit quadratic to your position vs. time data by (with the data of interest still selected) clicking on the Curve Fit button or through Analyze: Curve Fit. Choose the Quadratic under the list of General equations (note that the formula is in terms of the variable t with parameters A, B, and C; LoggerPro recognizes that you are working with data that is a function of time). Click the Try Fit button, then click OK.
i) Record the A value along with the reported uncertainty, as well as the RMSE value. Note that A doesn't have units provide. What should the units of A be?
j) Copy and paste the position vs. time graph (with best quadratic fit) and the velocity vs. time graph (with best linear fit) to a document for later resizing, cutting, and taping into your lab notebook.
k) Repeat steps b) – k) for the next bounce with smooth data.
l) Repeat for one more bounce, so that you have done this for at least 3 bounces.
m) Compare the three slopes obtained from the linear fits to the velocity vs. time graphs for the three bounces you examined. Given experimental uncertainty, are these slopes consistent with each other?
n) Compare the three A values obtained from the quadratic fits to the position vs. time graphs. Are these A values consistent?
o) **We will discuss this is a class. If you finish before the class discussion, see if you can assist someone who might be struggling by serving as a resource for any questions they might have.**