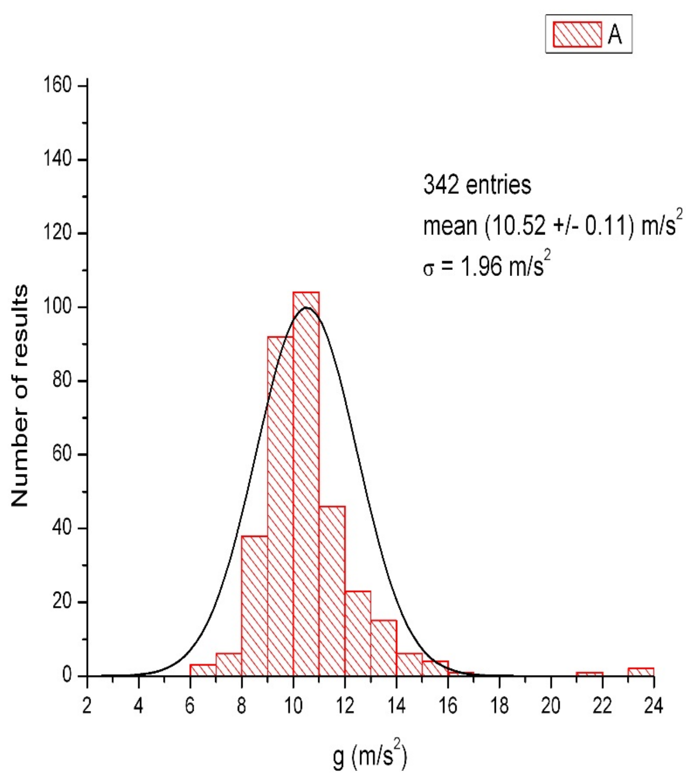
Lab #3 – CME

In the first lab experiment, Uncertainty, each group measured the acceleration due to gravity, *g*. Below is a histogram of the results from the entire course, plotted together with a Gaussian (or "*normal,*" or "*bell-curve*") distribution. The best estimate for *g* from this combined data is $g = 10.52$ +/- 0.11 m/s^2. The standard deviation of these results is $\sigma = 1.96$ m/s^2; this result says how much a given group's result typically varies from the average value (and indicates what the uncertainty is on a given group's answer). About two thirds of the students in the class should have obtained a value of *g* within one standard deviation of 10.52 m/s^2. The standard error of our results (or "standard deviation of the mean") is only $\delta = 0.11$ m/s^2. By averaging the results of 342 groups, we learn the value of *g* (as measured by this experiment) much better (uncertainty is only 0.11 m/s^2) than if we took only one student's result (for which the uncertainty is almost 13 times larger). This averaging makes the *statistical* uncertainty of our result very small ($\delta = \sigma$/sqrt(N)).



The discrepancy between the best measured result ($g = 10.52$ +/- 0.11 m/s^2) and the accepted value ($g = 9.81$ +/- 0.02 m/s^2) means either gravity has strengthened on the 4th floor of Rockefeller since October 21, 2003, the accepted value is wrong, or there were *systematic* errors in the experiment (such as using the small angle approximation in the derivation of our theoretical relationship between the length and period of the pendulum). Minimizing and estimating the sizes of such systematic errors is a key to successful physics experiments at all levels.

Section D. Gravitational Potential Energy

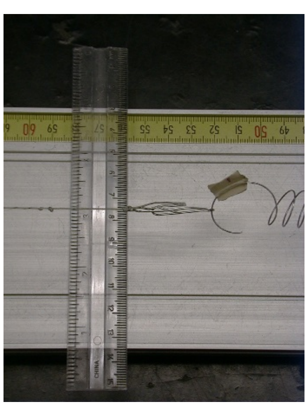
The picture below shows the general setup of this experiment.

Section D.1, Paragraph 1

You may discover that it's impossible to adjust the track so that the cart moves at constant speed over the entire length of the track; at several lab stations one will observe that the cart accelerates towards the center of the track and slows at the ends. Can you think of a plausible explanation for this behavior, one that you can check with equipment you have at hand? If you are working at one of these stations, you will need to incorporate this behavior into your error estimates.

Section E. Energy Stored in a Spring

The picture below illustrates how to use a ruler and either a knot or piece of tape to help you measure the position of the spring.

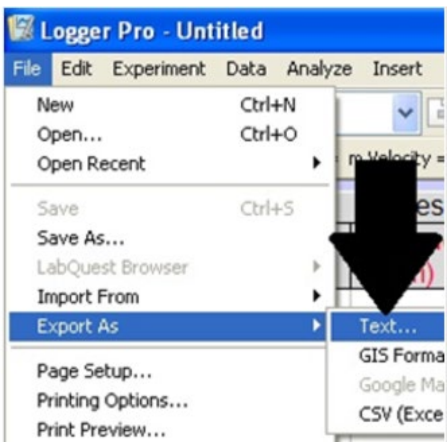


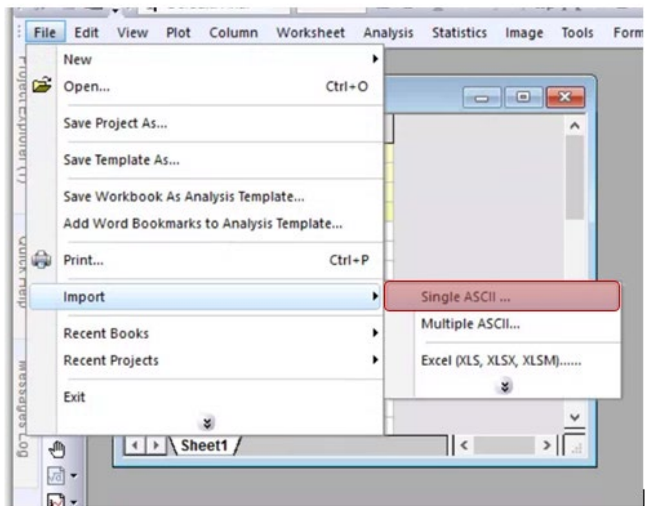
Lab 3 CME - Origin Guide

Here is a visual aide to help you through Mechanics Lab 3 - Conservation of Mechanical Energy!

Section D4:

1. After you take your data in Logger Pro, go to File-->Export (As)-->Text. You will get a dialogue box asking where to save it. Name it and save it to your file on the L:/ Drive. You may need to choose *.txt* from the drop down menu below the name of the file if it shows something like *.xls* or otherwise.

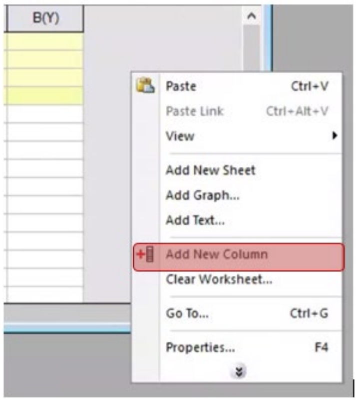




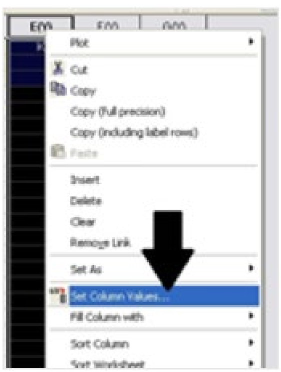
2. Go to Origin and select File-->Import-->Single ASCII. Find your file and select it. Your data should be in Origin now.
   a. **IF you receive an error about the file not being imported correctly,** chances are you did not open the correct logger pro file when you first began the lab. When in Logger Pro, go to Open, then select Programs(P:/)-->Logger Pro 3-->_Mech Labs-->CME. Sadly, you will have to re-take your data, or spend 30 minutes removing empty lines by hand.

3. If you still have columns for *Time(not t)* and *Gate State*, delete them. Also, remove any data at the top or bottom of your data that appears incorrect. You should not usually remove more than 5 lines each, however.

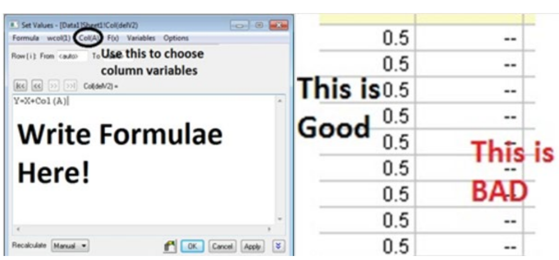
4. Add three(3) additional columns. You can do this by right-clicking in the gray space around the table and selecting *Add New Column*.
   a. Make sure you name your columns appropriately, so that you can figure out what is what farther down the line.



5. Right click on the column for K(inetic energy) and select *Set Column Values*. A dialogue box will appear where you can enter a formula. The formula is listed in the lab manual, but you should know the general form of the equation.

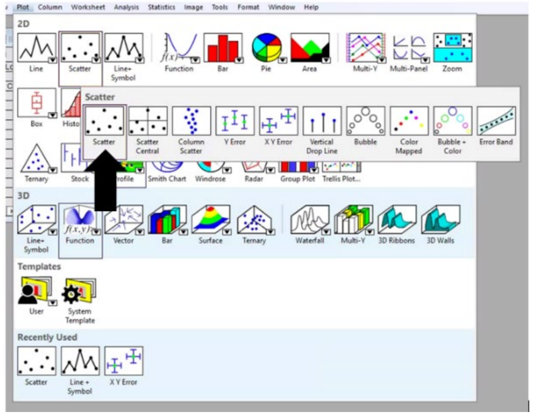


a. While doing this, it is important to note that you must put in your equations very specifically. Origin is quite picky about syntax. If you need to put in a reference to another column, you can either try to type it out, or use one of the drop-down menus at the top of the box.

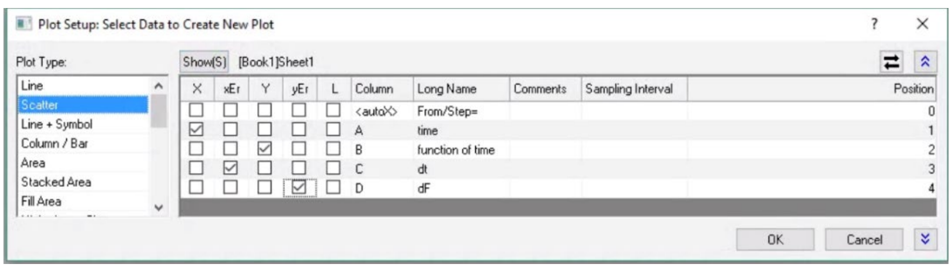


b. If you did everything right, you should get numbers in the columns when you press Apply. If you get dashed lines, check your equation; it means that you did something wrong.

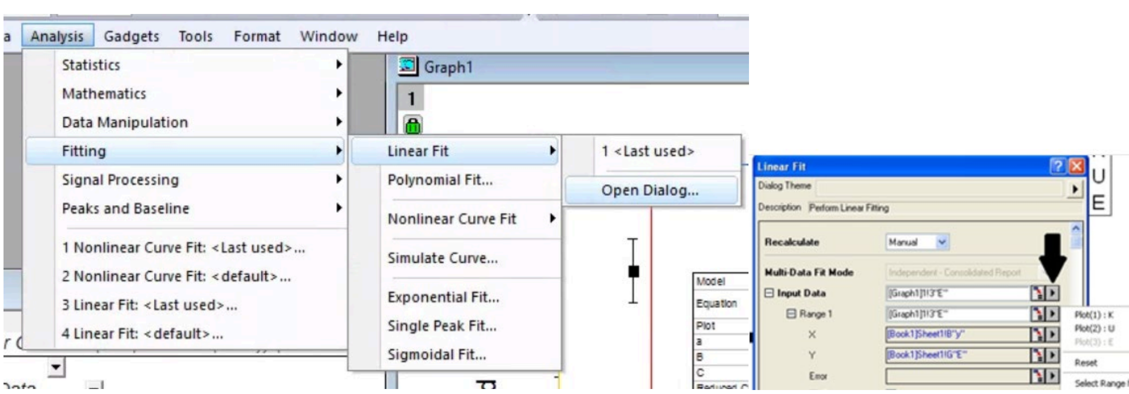
6. Do the same thing for U(potential energy) and E(total energy), using the right formulae for each.



7. Once you have data for those three, go to Plot-->Symbol-->Scatter. In the new window. Select the *y* data as the X data(ironically) and select *E* as the y. This is one of the few situations where it is alright not to have error bars. If you do not have an *Add* button, press the double arrow button on the bottom right, and then press add.
    a. Do this same thing for *y vs. K* and *y vs. U*. Once all three are added, press OK.



8. Once you get your graph, you need to fit a line. Go to Analysis-->Fitting--> Linear Fit(-->Open Dialogue). This new dialogue box only has one important piece of information that you need to change/check: *Input Data*. Make sure that this line has "E" listed, otherwise it will not try and fit a line to your total energy. If you need to change it, click the small arrow to the right of it and choose the right data.



9. Clean up the graph and save it to the L: drive, so that you can get it on your computer and then attach it to your report. Make sure that you label your axes with the quantities plotted and their units, you give your graph a title, and write your names on the graph, as well.

Section E2:

This section is quite straightforward: put your hand-taken data into Origin and plot it. Make a linear fit as described above, except that you only need to plot one set of data(instead of three) and you need not mess around in the linear fit dialogue box (just get to it and press fit). Follow the instructions above if you get lost.