Name_____

Date_____ Pd____

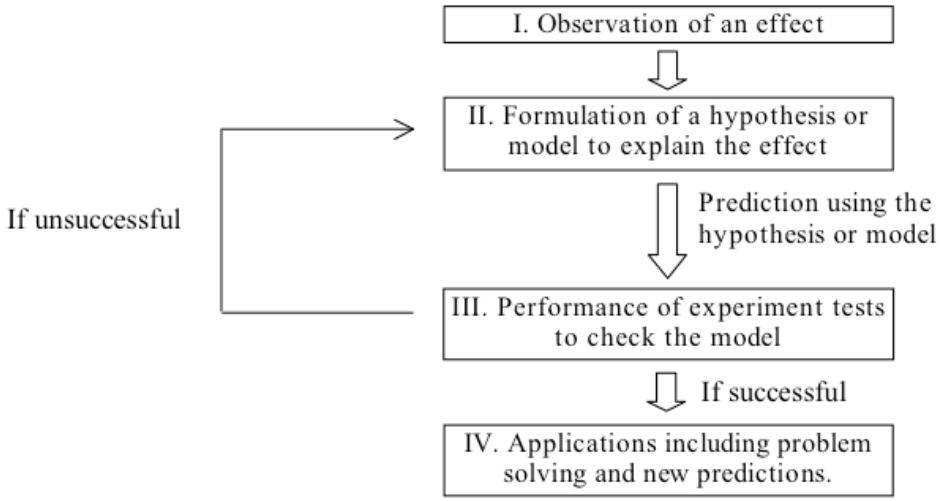
UNIT 1 CP LAB 2 - Introduction to Logger Pro

Goals: In physics, we will be using *Logger Pro* software both to collect and graph data. After completing this activity, you should be able to use *Logger Pro* to graph data and analyze it by curve fitting and statistical analysis.

Purpose: To determine the relationship between the height of a block of text and its width for a paragraph with a fixed numbers of words.

Introduction to the "Scientific Method"

The "Scientific Method" is the set of procedures that a scientist follows when he or she wants to investigate an effect. The procedures can be pictured as a flow chart:



Make a prediction

Hypothesis: Before making your hypothesis, refer to "CP Graphical Methods-Summary." Using the format under the column "Written relationship", describe how you expect the height of a block of text to depend on the width of a paragraph with a fixed number of words (how does the height changes when the width changes?). Substitute "width" for "x" and "height" for "y."

In a few sentences, explain the reasoning behind your prediction above.

Test your prediction

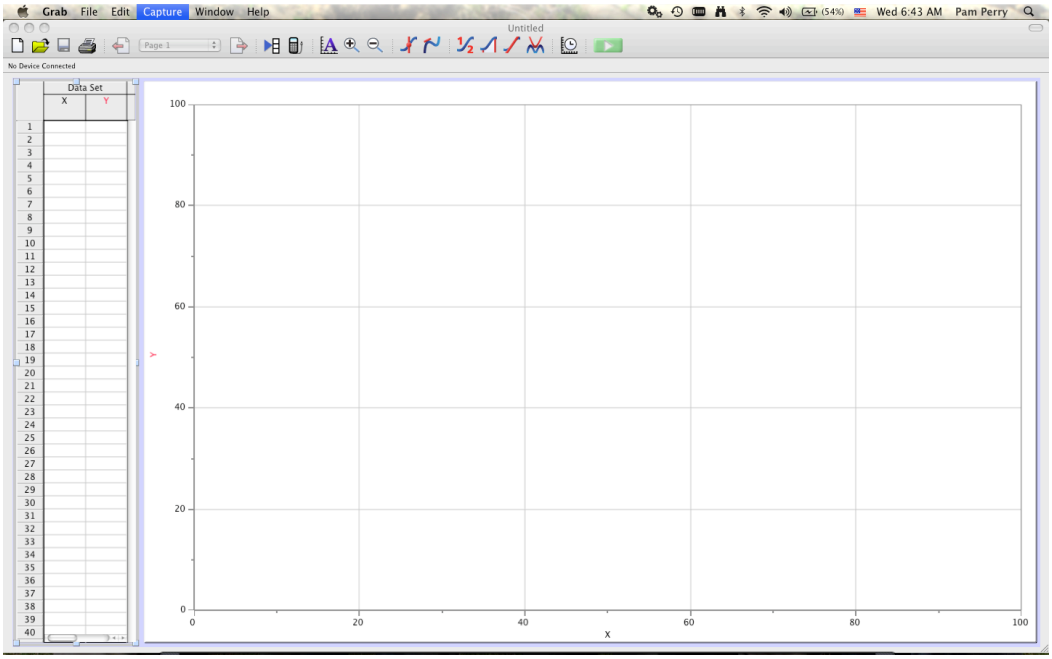
The first step in the "Scientific Method" is to observe an effect. To do this you will measure the heights and widths of a few blocks of text (paragraphs).

Procedure:

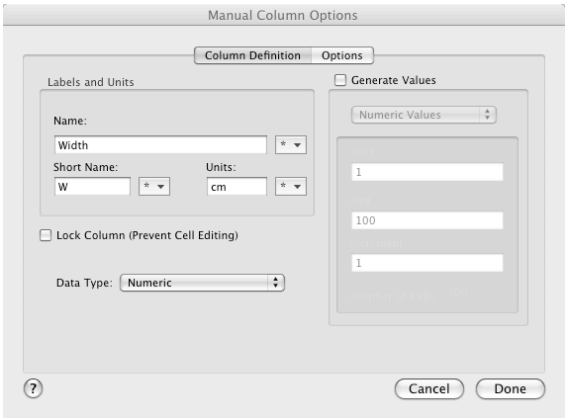
1. Attached to this lab, you have two pages covered in paragraphs of different widths. Every paragraph has the same number of words. Measure the width and height of **FOUR** of the paragraphs in centimeters (to the nearest millimeter or tenth of a centimeter) and record them in the table to the right.

Width (cm)	Height (cm)

2. You will now plot this data. Open *Logger Pro 3* on your computer. Your screen should look like that below:

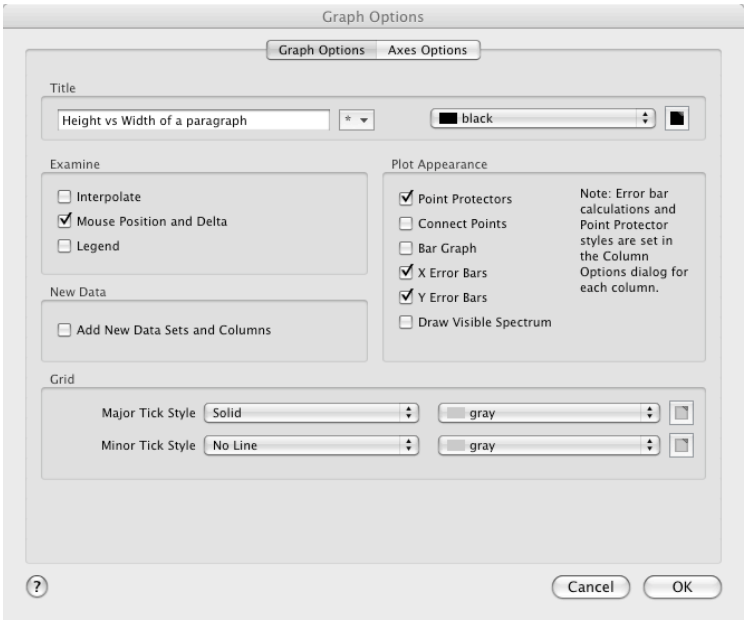


3. Double click on the column heading "X" and change "Name" to "Width", "Short Name" to "W" and, "Units" to "cm". Do the same for "Y" ("Length", "L" and "cm"). Enter your data for the paragraphs into the columns in *Logger Pro*.



4. For *Logger Pro* to plot the data, you need to order them. For that, select "Data", "Sort data" from the menu.

5. *Logger Pro* will then automatically plot the on the right hand side of the screen. However, the graphs that *Logger Pro* produces need some settings to be changed. Single click on  (Autoscale). Now double-click anywhere on the actual graph. A new window "Graph Options" appears:



6. Change the title of your graph to something appropriate. Turn off "Connect Points" and turn on "Point Protectors". Click on "Done", and make sure that your graph has width on the x-axis and height on the y- axis. You now have a scatter plot for your four points.

7. Does your plot agree with your hypothesis/prediction?

Find a Model

The next step in the scientific method is to formulate a model or hypothesis to explain the effect. A model or hypothesis is a provisional idea that needs to be checked. From the data you have already taken, you are going to predict how the height of a paragraph is related to its width. One way to do this is to find a straight line or curve that goes through the current points, and then suggest that the data from the other paragraphs will also fall on this line. This corresponds to finding an equation that shows height as a function of width.

Data Analysis:

8. Click on  or go to the "Analyze" menu and click on "Curve Fit". A new window opens.

9. Make sure "Fit Type" is set to "Automatic". Choose a "Quadratic" equation and click on "Try Fit". Record the values of the coefficients for the curve. Comment on how good the line or curve fits the four points (see Hint!). Repeat for a "Linear", "Inverse" and "Power" equation.

   Hint: It may be hard to visually choose between your best fit curves. In this case use the "correlation" or "RMSE" ("Root Mean Square Error") value that is displayed along with the coefficients in an automatic fit. An RMSE closer to zero generally means a "better" fit. If you use the RMSE to choose between your fits, make sure you write down the RMSE values that you get from each fit!

curve type	A	B	C	RMSE	how well does this fit?
Quadratic $y = Ax^2 + Bx + C$					

curve type	m (slope)	b (y-intercept)	correlation	how well does this fit?
Linear $y = mx + b$				

curve type	A	RMSE	how well does this fit?
Inverse $y = A/x$			

curve type	A	B	RMSE	how well does this curve fit?
Power $y = Ax^B$				

10. Which curve is the best fit? Explain why you chose this curve.

11. From your best fit, make a new hypothesis about the relationship between height and width.

You have now found a line or curve that fits your data, and predicts where future data points will be located. This way you have made a hypothesis and used it to predict the results of new observations. The next step in the scientific method is to test your model or hypothesis experimentally.

12. Measure width and height for the remaining paragraphs and record in the table to the right.

Width (cm)	**Height (cm)**

13. Add this new data to the data you already have in Logger Pro and find a new best line or curve to fit **ALL** the data. Record the type of curve that fits best and the values of the coefficients for the curve and the "correlation" or "RMSE." below.

curve type	**coefficients**	**RMSE**

14. **Print your graph and data:** to do this, either click on the printer icon or go to the "File" menu and click on "Print". Staple the graph to this packet.

Conclusions and Additional Questions:

15. Write a mathematical model or equation that best fits your data using the information from #13 (see your teacher if you need help).

16. Does your result confirm your hypothesis (is this new curve the same as your best fit curve from question #10? Explain. If not, why might your hypothesis have failed?

17. Will your prediction work for small widths (less than 1 cm) and for large widths? Explain why or why not?

18. What are the control variables in this experiment?

19. Why are the points not following the curve of your model exactly?

20. In your own words, briefly explain the steps of the scientific method.

Thanks to the Department of Physics and Astronomy, University of British Columbia for this exercise.

I went to see a Broadway show with my friend a couple of weeks ago. After the show ended, everybody in the theater stood up and headed for the exit. While we were waiting for the people in the seats next to us to exit the row, I commented that this was a "mass exodus." Then my friend looked at me and asked, "Are you sure? How do you know it's mass and not weight?" I then looked at her and said, "Because we're not being forced."

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