Introduction to Experimental Physics

Lab Notebook

Student Name:	Samuel Yao
Date:	Oct 10 2025
Course:	PHYS 13100
Lab Section / TA Name:	2L07 / Not Known Yet

A reminder: when completing your lab notebook, it's preferable to answer in short sentences and bullet points rather than long paragraphs. You don't need to use full sentences or any formal format… this record is *for you*, and the TA is just looking for it to be complete.

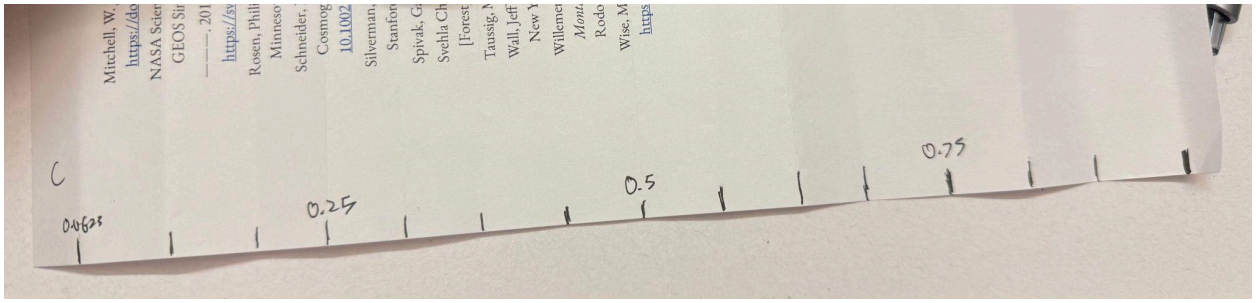
A note on symbols and equations: Inserting symbols and equations into your notebook is possible, but not always quick and easy (especially if you've never had to do it before). We don't want you to spend a lot of time figuring out formatting when you could be spending that time on physics. So consider the following shortcuts as you fill out your notebook.

> -You can insert an equation by selecting "Insert: Equation" from the menu bar
> -If you can't find a symbol in the "Insert: Special Characters" menu, then spell then spell the symbol out (for example... pi, delta_x, B_exp, +/-)
> -If you need to do a long block of math, it may be quicker to write it out on a piece of paper and take a picture.

Making measurements

Making your ruler

Using a standard piece of paper, make a ruler with however many tick marks you think are appropriate. Include a picture of your ruler, and describe how you determined where to place the tick marks. Try to come up with a more rigorous method than "hmmm... that looks about right".



The tick marks coincide with the fold marks of the paper. When a paper is folded, its fold mark is exactly half its original length. After folding the paper several times along its length, I obtained 16 marks, each approximately 0.0625 Charta.

Using your ruler

Measure all three length dimensions of your card and estimate the measurement uncertainties on each. Describe how you determined your uncertainties. Is one of the two methods described in the manual more appropriate here?

0.3125 Charta x 0.1875 Charta x 0.0044 Charta (Height x Length x Width/Thickness)

±0.0156 Charta uncertainty (This is determined by taking ¼ of the minimum tick distance, as the tick distances are relatively far apart and most measurements are very close to the respective tick distances)

The Resolution method makes more sense in this context because uncertainty arises from the inaccuracy of the measuring tool (the ruler) and not the phenomenon itself.

Think about your three measurements. What (if anything) could be biasing your values and how might you come up with a way to test for that? (You do not need to actually perform any additional tests. We're just looking for ideas.)

Because of how the paper was folded, there might be systematic errors in the actual length of the tick marks, as the paper is slightly raised/depressed. I guess that this could be "tested" by taking measurements of the paper's displacement relative to the table surface, but this bias could be alleviated by using non-folding methods to create the ruler and less malleable materials, such as iron, for the ruler.

There may be parallax errors arising from the viewing perspective, which result in the incorrect perception of tick marks. This could be tested potentially by taking multiple measurements of the same card to verify slight inaccuracies arising from parallax errors.

Calculating quantities

Compute the area of the face of your card, $A = xy$ (where x and y are the length and width of your card), and determine the propagated uncertainty, δA. Do you need to propagate the uncertainties in both x and y, or can one be neglected?

A = (0.3125)(0.1875) = 0.05859 Charta squared

$$\Delta A = 0.05859\sqrt{\left(\frac{0.0156}{0.3125}\right)^2 + \left(\frac{0.0156}{0.1875}\right)^2} = 0.005685\ Charta^2$$

All uncertainties are propagated because the uncertainty for all measurements is the same for whatever dimension.

Compute the volume of your card, $V = xyz$, (where z is the thickness of your card). What is the uncertainty, δV? Do you need to propagate the uncertainties in x, y and z, or can one or two uncertainties be neglected?

A = (0.3125)(0.1875)(0.0044) = 0.000258 Charta cubed

$$\Delta A = 0.0002578\sqrt{\left(\frac{0.0156}{0.3125}\right)^2 + \left(\frac{0.0156}{0.1875}\right)^2 + \left(\frac{0.0156}{0.0044}\right)^2} = 0.000914\ Charta\ Cubed$$

Comparing quantities and drawing conclusions

Compare your area and volume measurement to the three hypothetical classmates. For each, is your value in agreement, is your value in disagreement, or is it inconclusive?

Leslie Area: $t' = \frac{A-B}{\sqrt{(\delta A)^2+(\delta B)^2}} = \frac{0.09-0.05859}{\sqrt{0.03^2+0.00569^2}} \approx 1.03$ *(Inconclusive)*

Leslie Volume: $t' = \frac{A-B}{\sqrt{(\delta A)^2+(\delta B)^2}} = \frac{(0.000258)-2.0\times10^{-4}}{\sqrt{(0.5\times10^{-4})^2+0.000914^2}} = 0.1\ (Agreement)$

Wynn Area: $t' = \frac{A-B}{\sqrt{(\delta A)^2+(\delta B)^2}} = \frac{0.0593-0.05859}{\sqrt{0.0012^2+0.00569^2}} \approx 0.1220$ *(Agreement)*

Wynn Volume: $t' = \frac{A-B}{\sqrt{(\delta A)^2+(\delta B)^2}} = \frac{(0.000258)-1.68\times10^{-4}}{\sqrt{(0.04\times10^{-4})^2+0.000914^2}} \approx 0.0985$ *(Agreement)*

Omar Area: $t' = \frac{A-B}{\sqrt{(\delta A)^2+(\delta B)^2}} = \frac{0.052-0.05859}{\sqrt{0.009^2+0.00569^2}} \approx -0.619$ *(Agreement)*

Omar Volume: $t' = \frac{A-B}{\sqrt{(\delta A)^2+(\delta B)^2}} = \frac{(0.000258)-1.38\times10^{-4}}{\sqrt{(0.23\times10^{-4})^2+0.000914^2}} \approx 0.131$ *(Agreement)*

What is one improvement you could make to your ruler or to the way in which you made measurements that you think would reduce the uncertainty in your final measurements?

Smaller marks enable more specific measurement of the card's lengths, allowing the uncertainty to be further limited.

You likely did not find agreement or disagreement with all three of your hypothetical classmates. If you had the opportunity to talk to them, what are one or two questions you would ask them? What would it be important for you to know (or to see) if you wanted to better understand why you were in agreement or disagreement with them?

What sort of systematic or random errors did you account for in your methodology? What tools of measurement are used and what is their accuracy? What is the range of uncertainties?

Understanding the methodology of the different experiments will allow me to comprehend the varying results and how various factors contribute to them.