

Measurement Error
by
"Your Name"
And
Lab Partner - "Name"

Abstract

Hints for writing an abstract –

0) Write it ahead of time.

Don't waste time in the lab figuring out why you are there!

1) The MAIN purpose... again... THE MAIN PURPOSE of an abstract is to succinctly describe what you are trying to accomplish &/or prove &/or test. You may have more than one purpose.

In this lab, we will investigate variation of multiple measurements and quantify the uncertainty associated with items like a pipe's length and height of a flame. In addition, reasons for measurement variation will be explored.

2) You should also say HOW you are going to investigate/prove/test. Just mention the most important aspects of the procedure and equipment, so someone will have an idea how you did the experiment.

In this lab, we will investigate variation of multiple measurements and quantify the uncertainty associated with items like a pipe's length, and height of a flame.

So you will be making multiple measurements on those items listed.

3) Give a point of view of why you need to do the experiment. This example is more than you need.

Determining the distance between points or the mass of an object requires making a measurement, but is there even an "actual" or "true" value associated with a dimension such as length or mass.

Results

Here go **THE DATA PAGES** from your lab manual. Include units for your data in the table headings at least.

Calculation

If you need to do some calculations, display them after the data pages, but label them in some way so the reader knows which data they refer to.

$$\begin{aligned} 1) \quad \bar{X} \text{ (average)} &= (\bar{X}_1 + \bar{X}_2 + \bar{X}_3 + \bar{X}_4) / 4 && \text{SHOW GENERAL FORMULA} \\ &= (1.2 + 1.5 + 1.7 + 1.3) / 4 && \text{SHOW DATA USED} \\ &= 1.43 \text{ cm} && \text{SHOW ANSWER WITH UNITS.} \end{aligned}$$

$$\begin{aligned} 2) \quad t &= \sqrt{2 * S/g} \\ &= \sqrt{2 * 0.04/ 9.81} \\ &= 0.09 \text{ sec} \end{aligned}$$

$$\begin{aligned} 3) \quad \sigma^2 &= \frac{\sum_i (m_i - \bar{m})^2}{N - 1} \\ &= [(1.2 - 1.43)^2 + (1.5 - 1.43)^2 + (1.7 - 1.43)^2 + (1.3 - 1.43)^2] / 3 \\ &= 0.05 \text{ cm}^2 \end{aligned}$$

Show **ANY formulas** where the lab manual or data table requires you to "calculate" a value. **BE NEAT.**

Show work for **ONE** problem from each formula. Meaning show the data used in the formula. The reason for this is just to demonstrate that's you're performing the calculations correctly.

Show the answer with correct units.

HINT - The main error students make is using the wrong units or not writing the units. **ALL ANSWERS IN PHYSICS ARE MEANINGLESS WITHOUT UNITS .**
Ask the lab instructor if you are not sure of the units.

Discussion

The Discussion section is used to "account" for your data. Often you will be prompted with questions in the lab manual. Do you believe the data is correct? What about points that are "way out", try to explain those. What went wrong, what went right?

1a. Explain the possible sources of error in this measurement?

One possible source of error occurred with the alignment of the "zero" mark of the ruler with the edge of the tube. Also, measuring the length of the tube along different surfaces produced variation. This shows the length of the tube varies depending on where you make the measurement. A third source of error could be due to the precision of the ruler. The divisions of the ruler could be smaller to obtain less variation.

1b. How well did your measurements with the special ruler agree with those done with the plastic ruler? If there was a disagreement, what kind of error was it? Random or systematic? What caused this error?

Comparing the average value of the special ruler 8.23 cm to the plastic ruler 8.83cm one can see there is a discrepancy of 0.6 cm. Now, looking at the calculated uncertainty of both measurements, which equals approximately 0.05 cm, one can see the discrepancy of the average is far outside of the measurement's uncertainty. One can conclude there is definitely a disagreement between the two instruments and most likely this is due to type of error. The cause of this error from inspecting the instruments was due to

ANSWER IN COMPLETE SENTENCES. Do not just use words like YES or NO or The Ruler. You WILL NOT get credit for the question.

USE DATA ... STATE DATA..... REFERENCE DATA ... See answer to question 1b.

Conclusion

A conclusion will try to answer the questions or objectives brought up in the abstract.

Look at your Abstract to get the purpose. What are you measuring and why?

The conclusion should describe what you **LEARNT**, not what you **DID**.

Based on the rod measurement data, the difference between accuracy and precision is evident. The average length obtained from both rulers could be written to 3 significant digits based on the calculated uncertainty of 0.05 cm. Yet, the average values 8.23 cm and 8.83 cm for the special ruler and plastic ruler respectively did not agree. Precision, which is determined by the number of significant digits was identical for both rulers. However, which average value was correct or accurate, could not be established.

The two most uncertain measurements were the flame measurement at +/- 1 cm and the mass measurement at +/- 2 grams. In the case of the flame it was not the instrument but the object, the flame itself, which caused the high variation. For the mass measurement, again the instrument was adequate only this time the process was the reason for the variation.

Answer in **PARAGRAPH FORM with COMPLETE SENTENCES**.

USE DATA....STATE DATA....REFERENCE DATA . One purpose of this lab was to quantify uncertainty. So you should write what it is you calculated for uncertainty.

The conclusion should try to use facts. Likethis is larger by a value of

Do not state feelings or use WIMPY words. Likethat was a great lab I learned so much ... or the ball fell really fast...

In some cases the data may NOT allow you to reach a definite conclusion because of measurement uncertainty or other factors. This is OK. You just need to explain why. For example, half the data shows A is heavier than B and half the data shows B is heavier than A. Which is heavier A or B? You don't know, but you can conclude you don't know based on the data.