

Measurement and Measurement Error
by
"Your Name"

Lab Partner - "Name"
Lab Station #

Abstract

Determining the distance between points or the mass of an object requires making a measurement. After a measurement has been made one can then question how close to the actual value is this measured value. If additional measurements are performed, this will reveal a distribution of measured values, which raises more questions. Which measurement is correct? Also, is there even an "actual" or "true" value associated with a dimension such as length or mass? In this lab, we will answer these questions by investigating the variation of multiple measurements and quantify the uncertainty associated with items like a circle's diameter, a pipe's length, and height of a flame. In addition, reasons for measurement variation will be explored.

Hints for writing an abstract -

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 answer these questions by investigating variation of multiple measurements and quantify the uncertainty associated with items like a circle's diameter, 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 answer these questions by investigating variation of multiple measurements and quantify the uncertainty associated with items like a circle's diameter, a pipe's length, and height of a flame."

So you will be making multiple measurements on those items listed. You could also describe the measurement devices used. Like a ruler, scale, etc.

3) Give a brief intro. This will also give a point of view of why you need to do the experiment. This example is more than you need. I'm trying to give you ideas.

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

Error Analysis

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.

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

- 1) Show **ANY formulas** and algebraic working where the lab manual or data table requires you to "calculate" a value.
- 2) **Show work for ONE problem from each formula.** Meaning show the data used in the formula. The reason for this is so I can see if you're performing the calculation correctly.
- 2) **Show the answer with correct units.**
HINT - The main error students make is using the wrong units or not writing the units. **ALL ANSWERS HAVE TO HAVE UNITS unless the answer is unit-less, like ratios.**

Conclusion

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. By allowing the Nitrogen to evaporate over time a repeatable reading could not be produced.

1) You must answer in **PARAGRAPH FORM with COMPLETE SENTENCES.**

2) **MOST IMPORTANT** - 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?**

3) **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.

4) The conclusion should try to state 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...

5) 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.