Lab Worksheet: Error Analysis

Check your work with your TA for completeness & credit

Determining the degree of uncertainty:

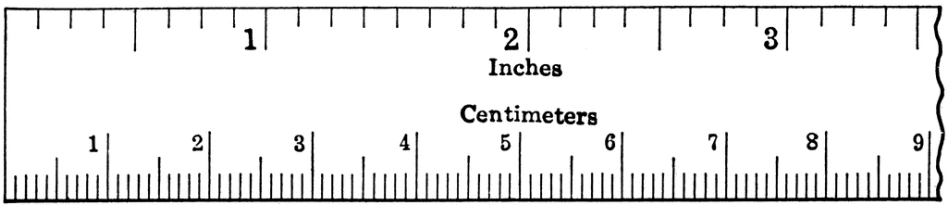
It is customary to report experimental results with the degree of uncertainty stated:

result = value measured ± uncertainty

This naturally raises the question of how do you estimate the uncertainty of a measured value? The answer to this question lies in determining the smallest fraction of the smallest division marked on a measuring device that can be estimated with reasonable accuracy.

Determining the least count and the Instrument Limit of Error (ILE):

The **least count** is the smallest division (graduation) that is marked on a measuring device. For example, the **ruler below has a least count of 0.125 (1/8) inches and 0.1 centimeters**. Notice the least count refers to the graduations (lines) on the measuring tool and not the numbers provided.



1) What is the least count for the following pieces of lab glassware in your locker? Include units.

a) 10 mL graduated cylinder: _____

b) 100 mL graduated cylinder: _____

c) 1 mL pluringe: _____

d) 3 mL pluringe: _____

e) 50 mL beaker: _____

f) 250 mL Erlenmeyer flask: _____

g) Consider the balances in the lab. Report the least count (smallest number) of the different types of balances below – choose any two with different digital readouts. You may need to go into the instrument room. Don't forget to include units!

Balance #1 _____

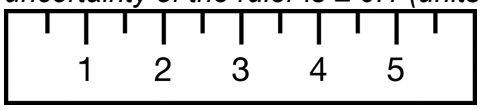
Balance #2 _____

TA Initials _____ (completed)

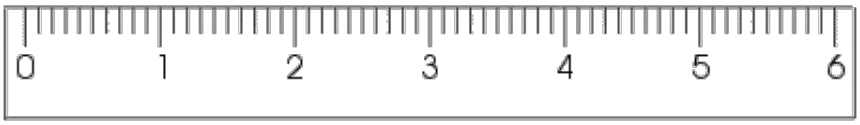
Read carefully and bring this worksheet to every lab.

The **instrument limit of error (ILE)** is the estimated accuracy to which a measuring device can be read. The ILE is a reflection of the uncertainty in measurements made with a particular device and is always equal to or smaller than the least count. The ILE is generally taken to be the least count or some fraction (1/2, 1/5, 1/10, etc.) of the least count. There are no set rules for which fraction of the least count to use in determining the ILE and different observers may report different ILE's.

- **If the space between the scale divisions is large**, you may be comfortable in estimating a fraction of 1/5 or 1/10 of the least count. A reader may estimate between the lines to 1/5 of the least count (0.5) in the figure below: 0.1, 0.2, 0.3, 0.4, or 0.5… (1/5 x 0.5 = 0.1). "*The uncertainty of the ruler is ± 0.1 (units not provided).*"



- **If the divisions are closer together**, you may only be able to estimate to the nearest 1/2 of the least count (0.1 cm). The reader may only estimate on the line or in between it in the centimeters ruler below: 0.05 cm or 0.10 cm…(1/2 x 0.1 cm = 0.05 cm). "*The uncertainty of the ruler is ± 0.05 cm.*"



- There are also situations where the divisions are so close to each other that you may only be able to estimate to the least count (smallest fraction = 1). The deciding factor is an evaluation of the smallest fraction of the least count that *you* can accurately estimate.
- **In digital readouts**, such as the balances, the reader has no say in determining the least fraction. *Consider how the last decimal place is determined*. There are many more sig figs than those provided so the last decimal place was rounded either up or down.

2) Estimate the ILE for the following instruments (include units for least count & ILE). If you are confused, carefully re-read the points above for examples. **Use distilled water to take one measurement with each device. Measure any amount within the capacity of the instrument. Report the measurement with proper sig figs and uncertainty (ILE).**

(Least Count) x (Fraction) = ILE

Table 1. Summary of Instrument Uncertainties

Equipment	Least Count	Fraction	ILE	Measurement (value ± ILE with units)
10 mL grad. Cylinder				
100 mL grad. Cylinder				
1 mL pluringe*				
3 mL pluringe*				
50 mL beaker				
250 mL Erlenmeyer flask				
Balance #1		-		
Balance #2		-		

TA Initials _____ (completed table & pipet/pluringe technique)