# LAB 2
# Measurements and Error Analysis

## OBJECTIVES

(1) Practice measuring, organizing and analyzing quantitative data.
(2) Create a spreadsheet using the Excel program.
(3) Use Excel to calculate the mean and standard deviation of a set of measurements.
(4) Determine whether your standard deviation is consistent with theory.

## EQUIPMENT

Meter sticks, lab tables, and Excel program.

## PROCEDURE

Form lab groups of about four people. Each person will make each measurement twice, giving you about eight values for each measurement. Write down your measurements and do not let your partners see your numbers. Try to make your own two measurements independent—that is, forget what you measured the first time when you make the second measurement. When everyone in your lab group is finished, **put all your measurements together**.

### Part 1: Measuring the Length of the Lab Tables.

(1) Use meter sticks to measure the lengths (in meters) of four of the eight tables in the lab room. Organize your data into a table in your lab notes and then enter the data into Excel. *Put the results from each of your lab partners into one data set so you have at least 32 measurements.*

(2) Use Excel's **AVERAGE** function to find the **mean** (average) length.

(3) Use Excel's **STDEV** function to find the **standard deviation** ($\sigma$) in the length. The standard deviation is the best estimate of the uncertainty in your individual measurements.

(4) Express your experimental value for the length of the lab tables as:

**value = mean ± standard deviation.**

**Part 2: Compare Your Measured Values with "Theory."**

(5) Theoretically, approximately 68% of the values of any measurement should fall within one standard deviation of the mean value. This means that 68% of your measured values should be ≥ (mean - σ) and ≤ (mean + σ). *What percentage of your measured values for the length of the lab tables fall within one standard deviation of the mean? Is this consistent with theory?*

(6) Theoretically, approximately 95% of the values of any measurement should fall within two standard deviations of the mean value. This means that 95% of your measured values should be ≥ (mean - 2σ) and ≤ (mean + 2σ). *What percentage of your measured values for the length of the lab tables fall within two standard deviations of the mean? Is this consistent with theory?*

**Part 3: Ape Index**

The "ape index" is the ratio of the arm span to the height of a person. Measurements of living beings are challenging (they vary depending on many factors) but they will give us good practice.

(7) Calculate the "ape index" for each of your lab partners. *Put the measurements from each of your lab partners into one data set so you have at least 24 measurements*

(8) Use Excel to calculate the mean ape index and the standard deviation. Express your experimental value for the ape index as:

**value = mean ± standard deviation**

(9) Repeat steps 5 and 6