Goal: To understand measurement error and its effect on data analyses.
To familiarize you with various measurement techniques.
Objective: To learn different measurement techniques used in archaeological analyses.
To identify sources of bias or measurement error in data.
To create graphical representations of data.

**Instructions**
There are seven stations. Each has a different measurement. At the end we will compile the information into class data to examine measurement error.

**Station 1: Measuring lithics (Lithics A & B)**
The axial width and axial length measure the dimensions of the flake relative to where it was struck. In general, differing amounts of force at different angles will produce flakes of different shapes. For example, greater force can produce larger flakes. Force that is directed more at an oblique angle rather than a vertical angle will produce a wider flake.

To determine axial length and axial length, you will need to find the bulb of percussion and the striking platform on the flake. These two landmarks identify where the flake was struck to remove it from the larger piece. The bulb should be a bump, which is represented in the figure below by the horseshoe shaped curve. The arc of the bulb points away from the point of origin, much like a ripple in the water extends out from where rock was dropped into the water. The axial length measures the length of the flake in the direction that the force traveled through the rock. The axial width is taken perpendicular to the length at the widest point.

Maximum length and width measures just the overall size of the flake. Maximum length is taken along the longest axis of the flake. Maximum width is taken perpendicular to max length at the widest point.

1) Measure the maximum length, width, axial width, axial length of the lithic items using a ruler.
   Use the millimeter scale, not the inches.
2) Record the finest increment on the ruler.
3) Enter these measurements on the data sheet and in the computer
Station 2: Measuring lithics, part 2 (Lithics 1 & 2)
1) Measure the maximum length, width, axial width, axial length of the lithic items five times using a caliper. To make sure the measurements are independent of each other, measure the different measurements on each item before remeasuring.
2) Calculate the mean and enter these values on the data sheet and in the computer.
3) Record the finest increment on the caliper.

Station 3: Measuring weight
1) Make sure the scale reads 0.0 g.
2) Put the item on the scale to weigh it.
3) Record the weight.

Station 4: Measuring rim angle
Rim angle measurements are used to determine the shape and function of a vessel from which the sherd came. Archaeologists use the angle to determine the shape of the vessel opening.

1) Place the sherd so that the rim is on the table surface. The cross section is facing you and the interior side of the sherd is to your right.
2) Rock the sherd back and forth. As you move the sherd, your partner will determine when the rim’s surface is completely flush with the table surface.
3) Place the goniometer so that center of the arm is at the point where the rim sherd touches the table, and zero degrees is on the interior side of the rim sherd.
4) Move the goniometer’s arm until it matches the angle of the rim coming up from the table.
5) Measure and record the angle of rim.
Station 5: Measuring rim diameter
Rim diameter measurements are often used in conjunction with rim angle measurements to determine shape and function of a vessel. The diameter tells us how large the opening of the vessel was.

1) Place the sherd on the diameter chart as above so that the rim is flush with the table surface.
2) Move the sherd out along each circle until the arc of the inside of the rim matches the arc of a line on the chart.
3) Record the measurement.

Station 6: Measuring hardness
Hardness is a standard geological measure that is often used to characterize and identify minerals and rocks. The Mohs hardness scale is often used to measure hardness. It consists of 10 fairly common minerals of known hardness which are ordered from softest (1) to hardest (10):

1. Talc
2. Gypsum
3. Calcite
4. Fluorite
5. Apatite
6. Orthoclase
7. Quartz
8. Topaz
9. Corundum
10. Diamond

Rather than carrying this kit around, common items are often used as substitutes in the field. We will be using the following items to measure hardness:

- Fingernail without polish (H=2.1)
- Penny (H=3.1)
- Steel probe (H=5.1)
- Glass (H=5.5)
- Streak plate (H=7)

1) Scratch the surface of the item with the object of known hardness.
2) Look for an etched line in the surface of the item. Rub the surface to make sure that it has been etched.
3) If the surface is etched, then the item is ‘softer’ than the object of known hardness. Try the next lower object of known hardness.
4) If the surface was not etched, then the item is harder than the object of known hardness. Try the next higher object of known hardness.
5) Record the hardness as a range.

Station 7: Measuring soil color
The Munsell Color chart is a standard way of measuring color. In archaeology, soil color charts are used to describe the color of the sediments or soils that are being excavated since color can provide clues to depositional history. It is also used to characterize the color of ceramics.

There are three components to Munsell colors. The hue is listed at the top of the page and refers to the color in terms of the colors of the rainbow, such as yellow, red-yellow, red, etc. The value is listed vertically on the left side of the page and describes the shift from light to dark. Chroma
is the listed across the top and describes the degree of departure from a neutral color. The standard notation is Hue Value/Chroma, for example, 7.5Y 2/3.

1) To determine the ‘color’ of the sherd, find the page where the hue best fits the sherd.
2) Next find the value and chroma for the sherd.
3) Record the hue, value, and chroma of each pottery sherd.
4) Estimate the range of error you think might make on each of these attributes.

**Lab Write Up**

Since the instructions cover most of the methods used in this lab, focus your write-up on the questions for the following sections.

**Results**

Identify the scale (nominal, ordinal, interval, ratio) of each measurement. For the measurements taken at the interval or ratio level, identify the accuracy of the instruments used to measure the items. Present this data in a table.

For each measurement, summarize the measurement graphically with one of the methods described in the textbook. Try to use as many methods as possible. Justify why you use a particular method.

Calculate the mean, mode, median, and standard deviation for measurements in the tables whenever possible. Present the information in a table.

Based on the mean, mode, and median, identify whether the distribution of the data is skewed positively, skewed negatively, or normally distributed. Then explain why the data might have this distribution.

Describe the range of variability amongst the different measurements in a table.

**Discussion**

Discuss the possible reasons why the symmetry and skew of each measurement varied.

Discuss the possible sources of measurement error for your measurements of each item.

Examine the range of variability for each measurement and discuss the possible sources of measurement error for the class data for each item, and why some measurements may have a greater range of variability than other measurements.

**Conclusions**

Summarize what you learned in this lab and what you should be aware of as you start to do your own analyses.