# Lab 12: Measurements Lab

## Objectives

This lab introduces ...

## Materials

1) 2 Liter Bottle
2) Bicycle Pump
3) Rocket Fins
4) Water
5) Scale
6) Angle thingie

## Theory

### What is a Measurement?

A measurement tells us about a quantity of something. For example, a measurement can inform us about how heavy an object is, dimensions of an object, how hot something is, etc. A number is assigned to a property through measuring. Measurements are performed using an some form of an instrument (eg: ruler, timer, thermometer, etc.).

### What is not a Measurement?

Some actions might appear to be measurements but are not. Comparing two sticks to determine which one is longer is not a measurement. However, if the length of each stick is measured and the difference in length is calculated is a measurement process.

### Accuracy vs. Precision

The figure below shows the differences between accuracy and precision. High accuracy involves having the mean (average) close to the target value. High precision involves having a low standard deviation (or a tight cluster).

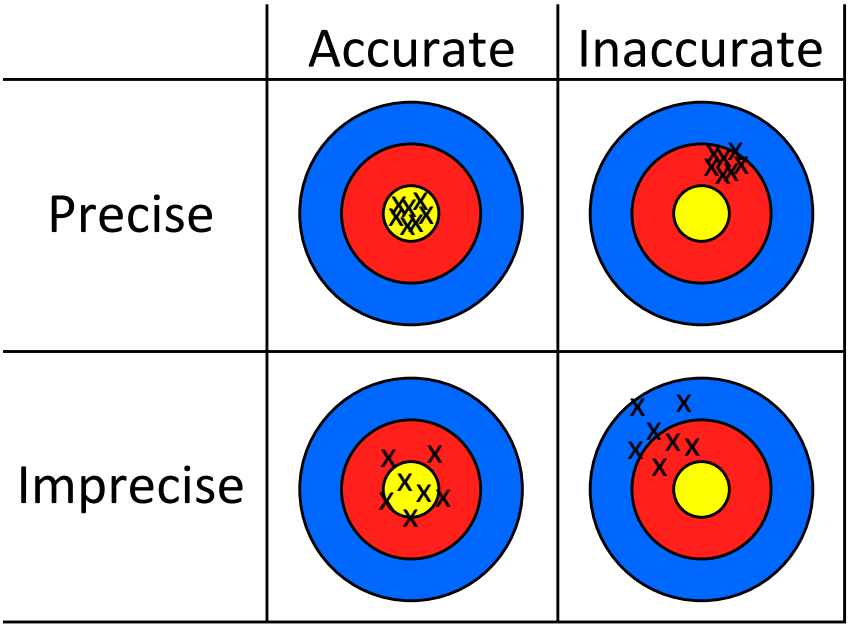


Figure 1: Accuracy vs. Precision

### Uncertainty

Measurement uncertainty is based on the level of confidence for measurements. Consider the ruler below, is the arrow pointing at 9.5 *cm*, 9.6 *cm*, or 9.56 *cm*. Uncertainty for measuring stems from the precision level (the smallest tick) of the measurement device. Sensitivity of a sensor provides the same uncertainty of a measurement. An ultrasonic sensor that has a sensitivity of $\pm 1$ *cm* makes it makes it difficult to know an object 7.4 *cm* away because the sensor reads 7 *cm*.

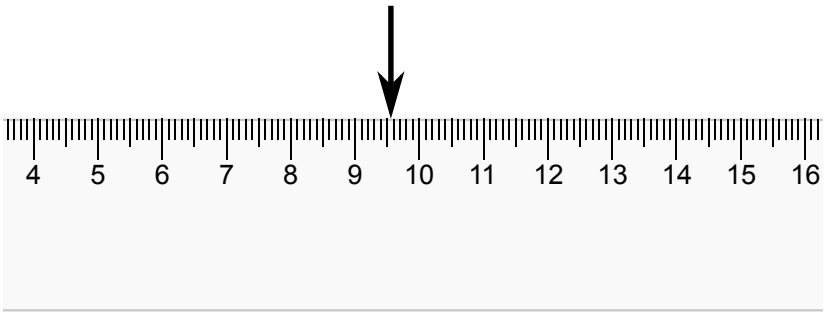


Figure 2: Measurement Uncertainty

## Laboratory Exercises

1. First do ...
2. Second, ...

## Subsection

1. First do ...
2. Second, ...