Significant Digits in Experimental Results

Average ± Standard Deviation

When you make a measurement in lab, your measurement should include all of the digits you are certain of, plus one final digit which is an estimate. For example, when reading a measuring cup where the water level is between two markings on the cup, the last digit in the volume measurement is estimated based on where the water level is compared to the nearest markings. The significant digits in a measurement include all of the certain digits plus one final uncertain (estimated) digit.

When we carry out an experimental procedure, our final result is not just based on the initial measurements, because error can creep into our results at any point along the way. How do we know how much error crept into our final number, and how do we know how many digits we should report in our final answer?

The best way to determine how reliable your results are is to do multiple trials of the experiment and then calculate the average and standard deviation of the results. Standard deviation is a statistical calculation that is a measure of how much scatter (or uncertainty) there is in the data. If you round the standard deviation to one significant digit, that will tell you in which decimal place the uncertain digit of your final result lies.

For example, ten quarters were weighed, and the average weight was calculated to be 5.67387 ± 0.046377 grams. Rounding the standard deviation to one significant digit gives us 0.05. This tells us that the variability occurs in the hundredths place, or in other words, the uncertain digit in the weight of a quarter is in the hundredths place. Since the number of significant digits in a measurement includes the first uncertain digit, we would report the weight of a quarter to be 5.67 ± 0.05 grams.

For experimental results, determining significant digits this way is a more reliable way of reporting precision because it takes experimental error into account and is not based solely on the initial measurements themselves.