CH204 Experiment 1

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Are the Densities of Coke and Diet Coke Different?

$$d = \frac{m}{V}$$

Today

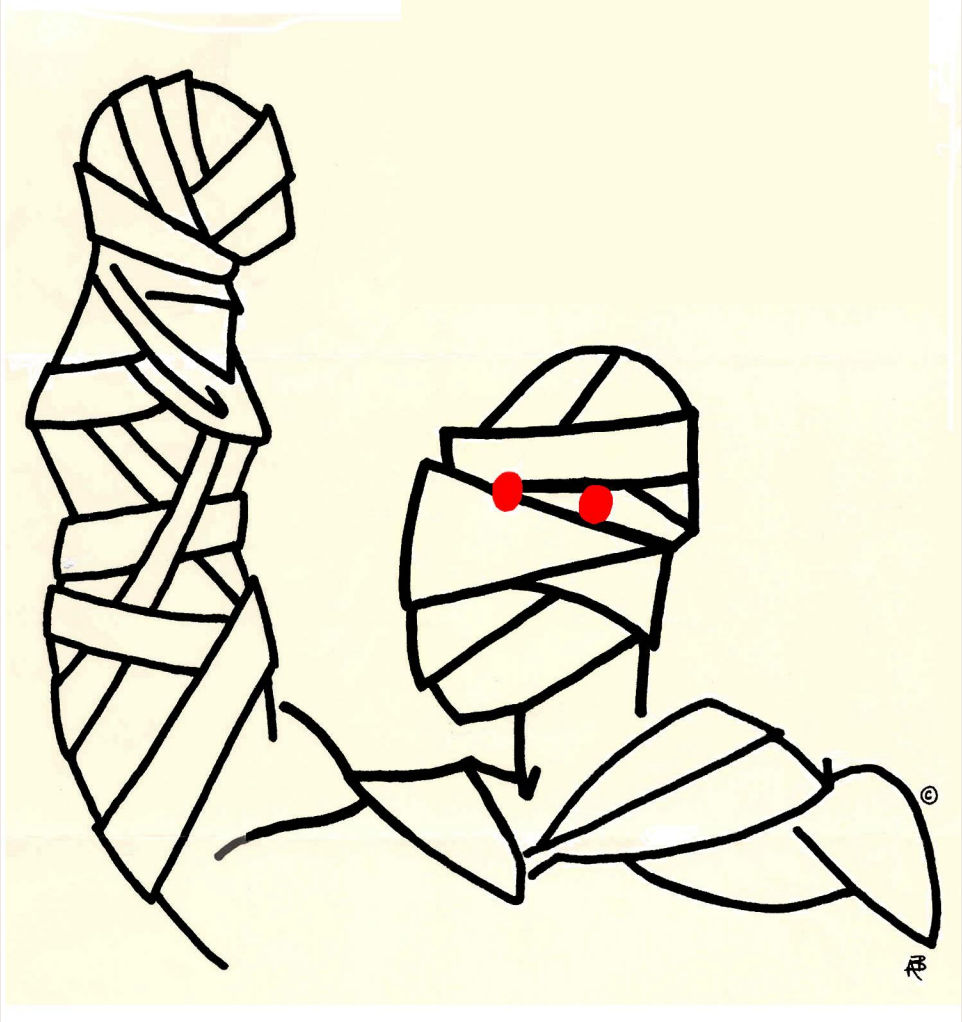
- **Random error in experimental data**
- **Calculating standard deviation**
- **Reporting significant digits**
- **Quick look at Experiment 1**

But first…

A word or two about significant digits…

…three words, actually.

The Mummy Lives!™



Every data point is an estimate!

But how good of an estimate is it?

If we don't know the true value, how do we know how much error there is in our measurement?

Ways of Determining Experimental Error

For a single reading:

Precision of the equipment

Tolerance of the glassware

For many readings:

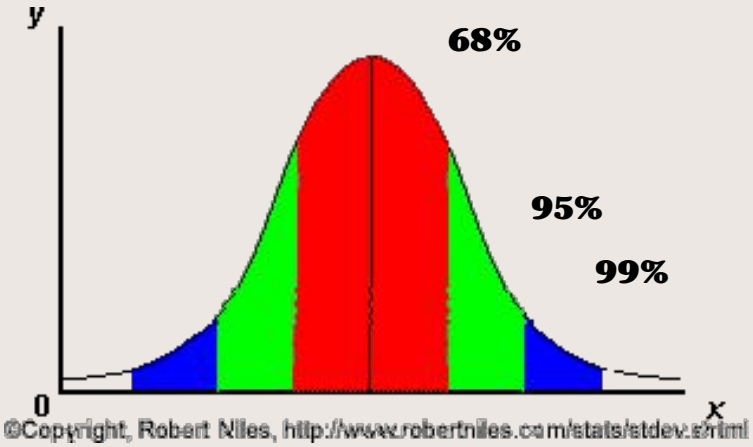
Statistics!

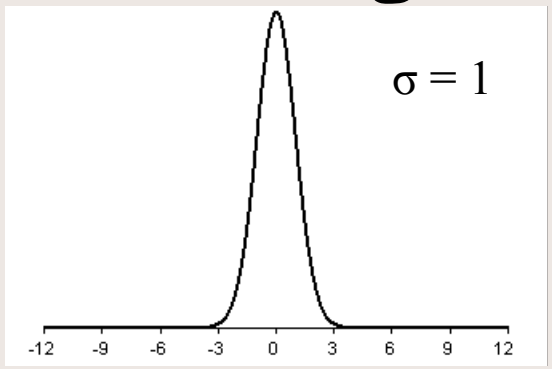
This is what we're gonna do in lab today.

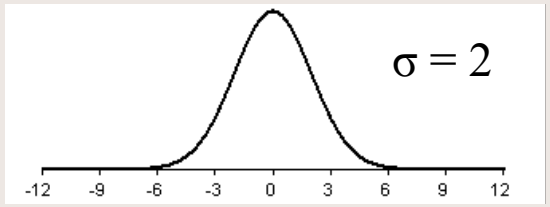
What is Standard Deviation?

It's a calculation based on a set of data points that tells us how widely the data points are scattered around the average.

$$\sigma = \left[\frac{\sum (x_i - \bar{x})^2}{(n-1)} \right]^{1/2}$$





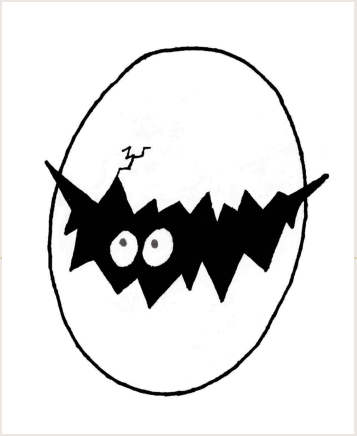


Standard deviation will limit significant digits

Experimental error is reported to only ONE significant digit.

Report the average only to the decimal place where the error occurs, even if this means reporting fewer digits than you would otherwise be allowed.

An Egg Sample



S'pose we have these data points:

1.0593 1.1676 1.0909 1.0438 1.1305

The average is 1.09842.

Normal significant digit rules say we can keep five digits: 1.0984.

So far so good. But...

...if these numbers are experimental data, there is some amount of random error "hidden" in each one of them.

How much random error is there in this data?

To find the hidden error

Calculate the standard deviation:

1.0593 1.1676 1.0909 1.0438 1.1305

=stdeva(1.0593, 1.1676, 1.0909, 1.0438, 1.1305) =

0.050954.

Round it to ONE significant digit: 0.05.

Round the average

Standard deviation = experimental error

The significant digit falls in the hundredths place, so our average must also end in the hundredths place.

This is IMPORTANT!

1.0984 ± 0.050954 becomes

1.10 ± 0.05

...and the moral of the story

We measured data to five significant digits, but our experimental procedure had considerably more error than those numbers indicate.

So even though we measured our data to five significant digits, we only keep three. The other two digits are insignificant because they are less than the experimental error.

Calculate, round, repeat

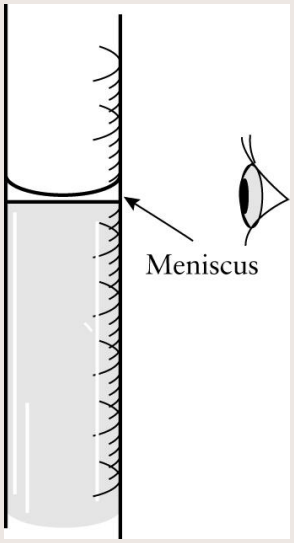
We'll use this same procedure to determine random error and significant digits *six times* in Experiment 1.

And speaking of Experiment 1…

Equipment

Graduated cylinder
Volumetric pipette
Burette

0.01 mL



Analytical balance

0.0001 grams!

Two-Part Lab

Part One:

- Measure the mass of 5 mL of sample using the analytical balance and three different types of glassware (pipette, burette, and graduated cylinder).

- Calculate density. Total of six data points.

- Enter your results into the spreadsheet on the computer nearest the printer, and use all the class data in your report.

Two-Part Lab

Part Two:

- **Measure your assigned volume using a burette, and measure the mass of the sample on the analytical balance.**
- **Do NOT calculate density.**
- **Enter your mass and volume measurements into the spreadsheet on the computer nearest the door, and use all the class data in your report.**

Important!

You will need all three graphs:

Part One:

1 - Density chart and graph comparing different methods (includes average and standard deviation for each method).

Part Two:

2 - Mass vs volume graph for Coke

3 - Mass vs volume graph for Diet Coke

Handling bad data

If you know it's bad – because you know something went wrong, or because the number is physically impossible - you can discard it.

If you don't like it because it's widely scattered, you can't just toss it, you have to apply the Q-test (see the appendix of the lab manual).

Interpolation

In order to calculate the density of water at the same temperature as your Coke or Diet Coke sample, you will have to interpolate between the density values in the table on page 7 of the notebook.

To the Doc Cam!

Final comments

Type with your fingerds, not witjh youpr thumbds.

Beakers are not volumetric!

Remember to rinse your burette and put it away.

Final final comments

Quiz next week during lecture.

There are a couple of sample quizzes on the web site Freebies page.

Bring a calculator!