CH204 Experiment 1

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Fall 2007

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**

How much does a quarter weigh?

Weigh a few more…

5.7128	5.6947
5.7085	5.6907
5.6106	5.6339
5.6009	5.7205
5.6466	5.7195

Now what does a quarter weigh?

Average = 5.67387

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 variability (random error) there is in our measurement?

There's got to be a better way!

There is. Calculate the

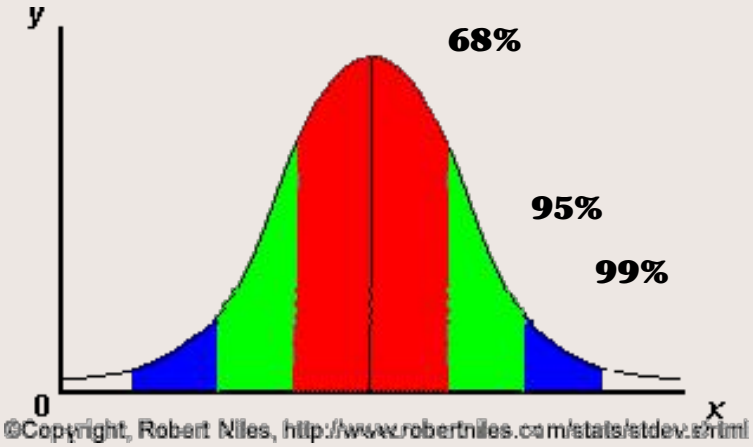
average ± standard deviation

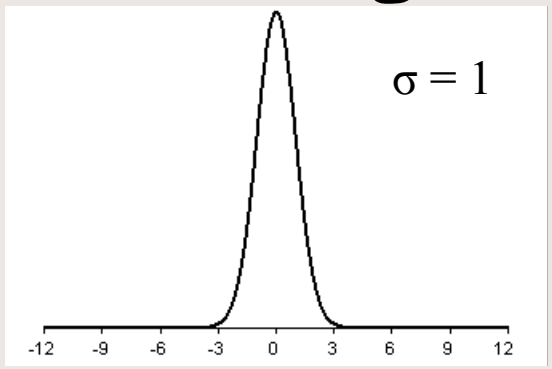
Standard deviation is a measure of the scatter in the data – and it also tells us how many decimal places we should keep in our average.

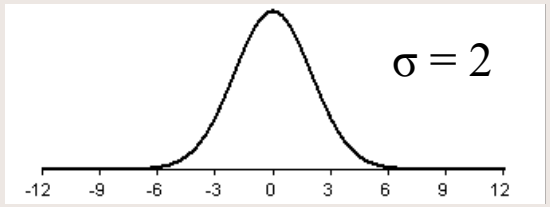
What is Standard Deviation?

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

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







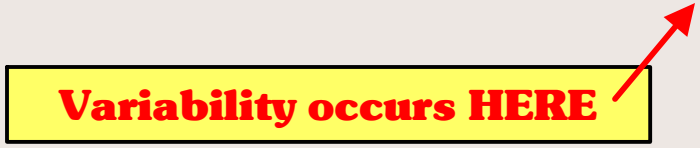
Calculating Standard Deviation

This is 2007. Use a built-in calculator function or use Excel. Don't calculate it by hand.

Let's head to Excel right now and see how E-Z this is.

So now what does a quarter weigh?

5.67287 ± 0.046377 g



Only report data up to the first uncertain digit – which is the same decimal place where the standard deviation falls.

This is really important, folks!

5.67287 ± 0.046377 g

Round the standard deviation to ONE significant digit: 0.05

And report the average only up to that decimal place: 5.67

Variability (random error) limits your answer

5.67287 ± 0.046377 g

should be reported as

5.67 ± 0.05 g

And that's what a quarter weighs!

So what does a quarter weigh?

5.67 ± 0.05 g

68% of all quarters should weigh between 5.62 and 5.72 grams.

5.7128	**5.6947**
5.7085	**5.6907**
5.6106	**5.6339**
5.6009	**5.7205**
5.6466	**5.7195**

Variability limits significant digits

There were five significant digits in the mass of each quarter, but only three significant digits in the final result.

The last two digits are insignificant because they are less than the variability in the measurement.

"Variability in the measurement" = experimental error.

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.

Std. Dev. = random error

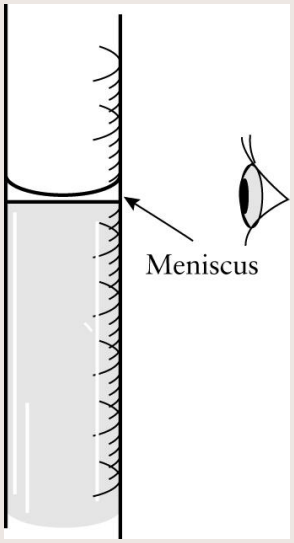
We'll use this same procedure to determine random error and significant digits in Experiment 1.

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:

- **Dispense 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 8 of the lab manual.

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

Next week: Final Exam, Part 1.

There is a sample quiz on the web site Freebies page.

Bring a calculator!